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American Journal of Diseases of Children

VOL. 6 JULY, 1913 No. 1

THREE TYPES OF OCCLUSION OF THE ESOPHAGUS IN EARLY LIFE*

THOMAS MORGAN ROTCH, M.D.
BOSTON

The following cases of occlusion of the esophagus of non-traumatic origin have been under my care in the wards of the Children's Hospital. The rather unusual occurrence of the condition in my experience and the importance of recognizing which type we are dealing with, on account of prognosis and treatment, are my reasons for reporting them. Considering the rarity of the condition it is to be noted as a coincidence that during Dr. Morse's service, preceding mine, three cases of esophageal narrowing entered the same wards and have been reported by him.

CASE 1.—The first case is that of a boy 25 months old. The labor was normal and the infant was normally developed. He was fed on breast milk for the first seventeen months. From birth he had always vomited, from four to six times daily. The vomiting had always occurred during the feedings and was never forcible. The child gagged or coughed a little and a considerable amount of the feeding would come out of his mouth. Sometimes he vomited just as he began his feeding and the amount then was a great deal more than he had just swallowed. The vomitus consisted of unchanged milk, not curdled or sour, and had no regular relation to the feedings. Sometimes he would retain several feedings and then vomit during the next two or three. He not only vomited breast milk but modifications of cow's milk. He seemed to be always hungry and had to be fed at least twelve times a day. It was found that he vomited less if he had only three ounces given at a feeding. He had always been constipated and he soon became a pale, thin baby.

Physical examination, beginning with the mouth and throat, was negative except for the heart, which was found to be decidedly dislocated to the right, and there was a blowing, systolic murmur, loudest at the base and transmitted to the left axilla. There was no systolic retraction. The urine was normal. Listening with a stethoscope over the epigastrium, when the child was swallowing, a slight splashing sound was heard fifteen to twenty seconds after the mouthful of milk had been swallowed. The sound was like that of a metallic trickling as though the milk came into the stomach by drops. The usual time for liquid to pass into the stomach at this age is five seconds.

A bismuth meal was given and a Roentgen examination immediately made. This showed a narrowing of the lower third of the esophagus extending not quite to the cardia. The esophagus was shown to be a little to the right of the median line and there appeared to be pericardial and mediastinal adhesions. The esophagoscope showed a stricture of the esophagus about 17 cm. from the incisor

*Read at the meeting of the American Pediatric Society, Washington, D. C., May, 1913.

teeth, approached by a funnel-shaped narrowing while the upper part of the esophagus was found to be slightly dilated. The narrowing appeared very great and a sound, ¼ cm. in diameter, could not be introduced. It may be said here that the distance from the gums to the cardia in the newborn is about 17 cm. and at three years from 23 to 24 cm. Figures 1, 2 and 3 show the stricture and 2 and 3 show that a certain amount of the bismuth meal had trickled through into the stomach. The child lost rapidly in weight and strength and the stricture was so small that it was deemed dangerous and therefore inadvisable by Dr. D. Crosby Greene to attempt to dilate it through the esophagoscope by the usual means. I might say in passing that in congenital cases, of which type this seemed to be, there is apt to be increased connective tissue around the esophagus which may extend down and form adhesions and thus displace the heart. It was these adhesions which were supposed to have caused the dislocation of the heart to the right. The only means of saving the child's life appeared to be a gastrectomy which would permit of the child's being fed directly into the stomach, and it was thought that when the general condition improved he might be able to stand the manipulation necessary to dilate the esophagus. The operation was performed but the child died. No autopsy was permitted.

This case represents an extreme congenital organic condition of a type which as a rule is inoperable and is almost universally fatal.

Case 2.—The second case is a more favorable type for treatment and for life. This case represents a type of probable congenital narrowing not necessarily, however, of organic lesion in the esophagus but caused by congenital central spasm, resulting in dilatation of the esophagus above the point of narrowing. A girl of 10 years old, normal at birth, was fed on breast milk for eleven months and during this time was well and strong. She was then given cow's milk and cereals and at once began to vomit regularly during her meals. She would vomit several times while taking her food. The amount vomited was small, never more than a few mouthfuls. The vomiting caused her a good deal of effort and distress until she learned to aid its occurence by putting her fingers down her throat. This continued until she was 4 years old and she had become a thin, pale, constipated child. At this time she swallowed a piece of meat in her soup and for four days following she vomited everything, even water. The vomiting then gradually lessened and she was kept on a diet of milk and cereals for two years. Since that time she had developed well and had become a strong, well girl. There was no history of her having swallowed anything corrosive. Four days before she was seen at the hospital she ate an orange and an hour later she was unable to eat her dinner because of discomfort which was only relieved by inducing vomiting with her fingers. She was unable to swallow anything, even water, without having to vomit it directly. She was in a very weak condition.

Nothing abnormal was found on physical examination. A bismuth meal was given and a Roentgen picture showed that the bismuth had passed only a little way beyond the middle of the esophagus, as shown in Fig. 4, and that there was none in the stomach. The part of the esophagus containing the bismuth was shown to be greatly dilated and at the bottom of this dilatation a circular object was made out the size of a small coin. An oval esophagoscope 1½ by 1 inch in diameter was passed into the esophagus by Dr. Greene and encountered a mass of orange pulp mixed with the bismuth. This was withdrawn and was found to be practically the whole of an orange pulp. Entangled in it was a penny. After removal of the obstruction the esophagus was examined. Marked dilatation of the lower third was observed, and a constriction ½ cm. in diameter at a distance of 25 cm. from the incisor teeth. The distance for a child of this age should be about 27 to 30 cm. The stricture was dilated and it was then found that a sound, 1.6 cm. in diameter could be passed. The child could then take soft solids without discomfort. Figure 5 shows the stricture after the obstacles had been

Fig. 1.—Stricture of the esophagus.

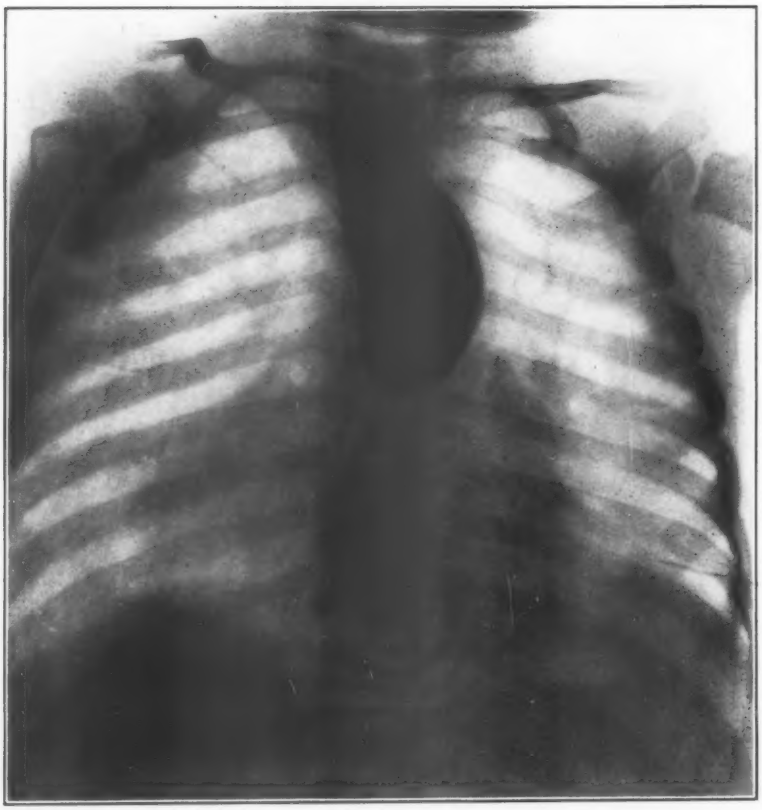

Fig. 2.—Stricture of the esophagus showing that a portion of the bismuth meal had trickled through the stricture into the stomach.

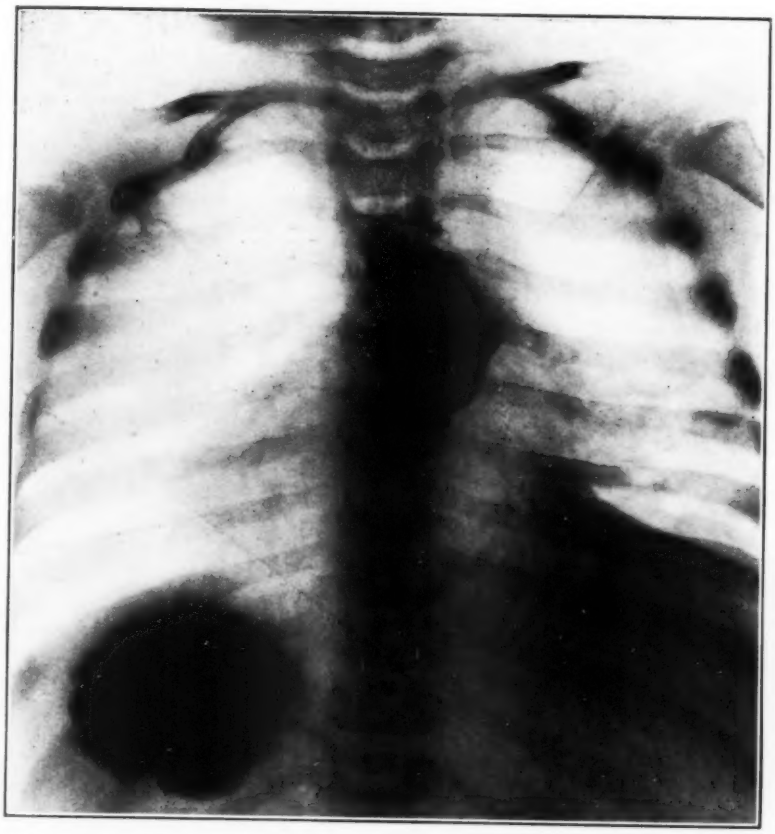

Fig. 3.—Stricture of the esophagus. A portion of the bismuth meal has trickled through into the stomach.

Fig. 4.—Stricture of the esophagus in a girl 10 years old, showing that the bismuth has passed only a little way beyond the middle of the esophagus.

Fig. 5.—Stricture in same case as Figure 4 after obstruction in the form of orange pulp and a penny had been removed and dilatation performed.

Fig. 6.—Stricture of the esophagus of the spastic variety in a boy 5¾ years old. The bismuth is shown as having passed into the stomach. There was no pyloric stenosis.

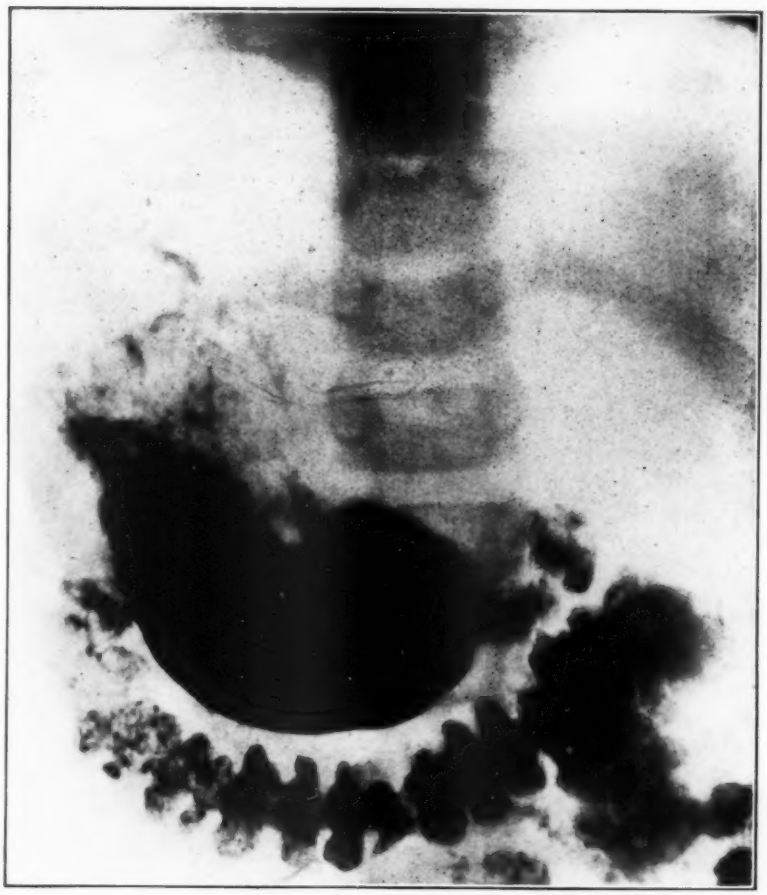

Fig. 7.—See Fig. 6 for description.

Fig. 8.—Showing the stomach tube in the stomach after brief resistance at the cardia. Same case as Figures 6 and 7.

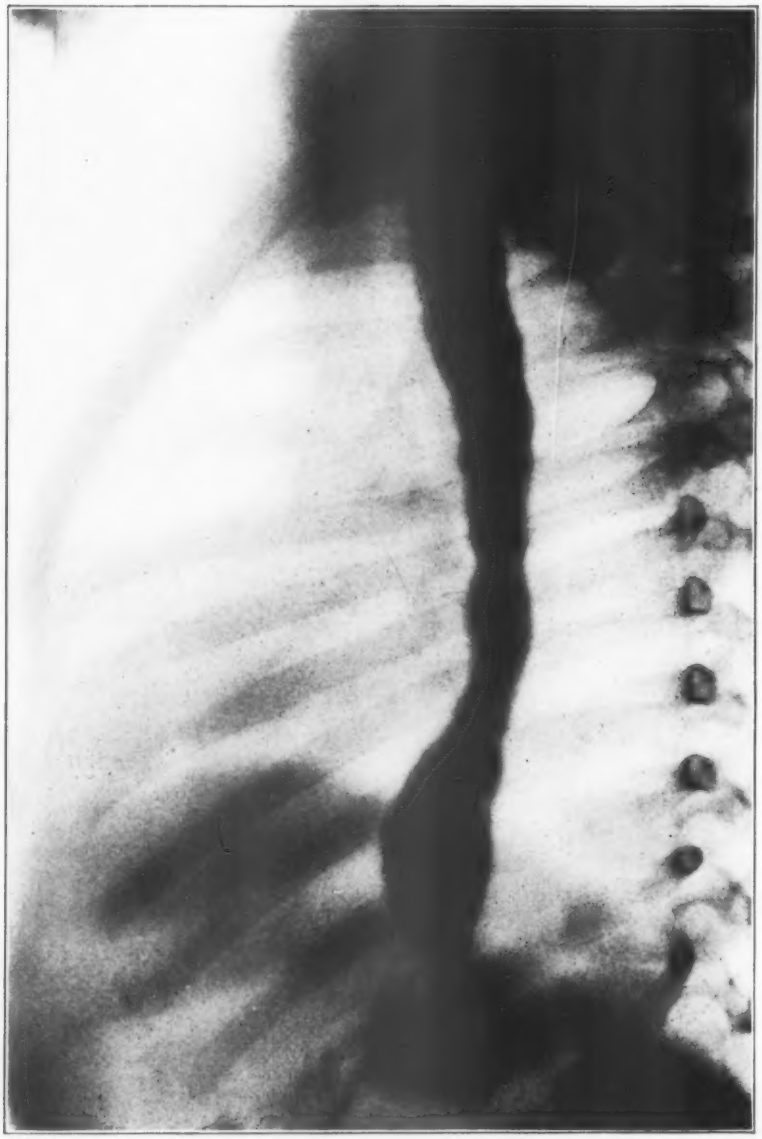

Fig. 9.—Same case as Figures 6, 7 and 8, the child lying on his face, the esophagus full of bismuth and the presence of a stricture in the cardiac end of the stomach.

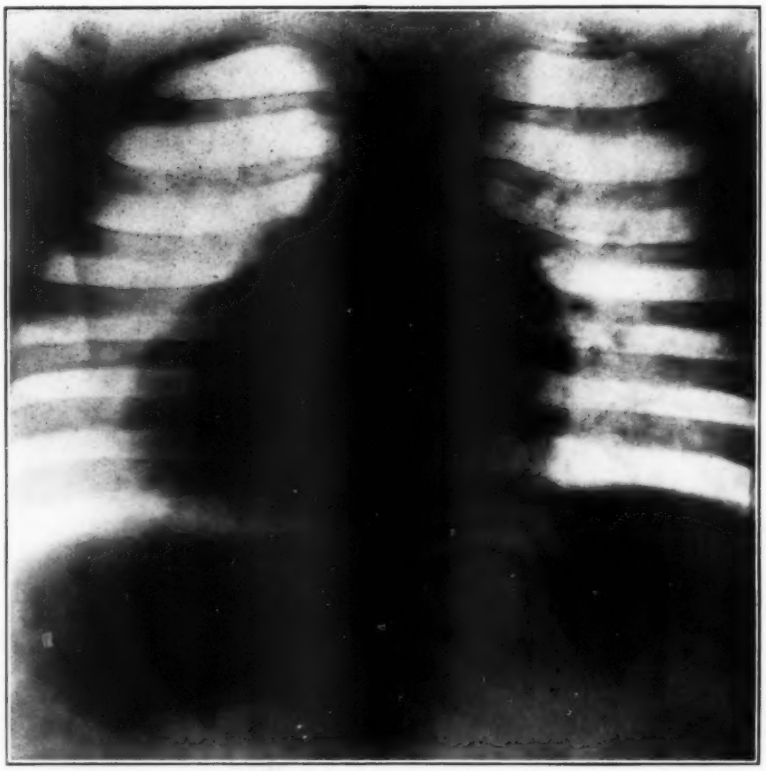

Fig. 10.—Same case. Roentgen picture taken after bismuth meal, following treatment by dilatation, showing that the bismuth has passed freely into the stomach.

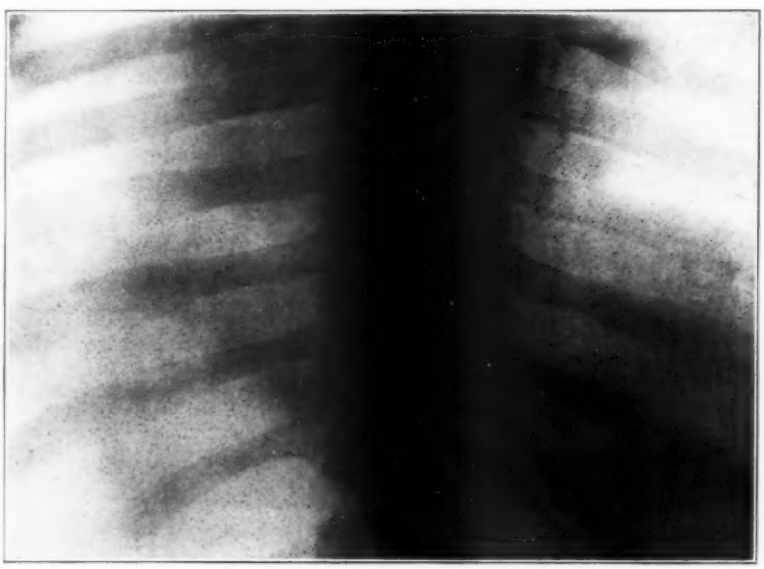

Fig. 11.—Same case. On a recurrence of the symptoms, this radiograph was taken, showing the presence of a coin which was prevented by spasm from entering the stomach. It was removed with the aid of the esophagoscope.

Fig. 12.—Same case. A week later, vomiting having recurred, the esophagoscope was passed and a piece of bristle discovered, which was removed. It had caused spasm.

removed. The child gained in weight and strength and after having the esophagus dilated at intervals, got entirely well, and on leaving the hospital was eating the regular house diet.

This patient is one who, from time to time, should be treated by dilatation through the esophagoscope, and will, under these conditions, probably continue to do well. The intervals for necessary dilatation will grow longer, and eventually dilatation will, in all probability, be unnecessary.

The history and appearance at the first examination inclined Dr. Greene to the belief that the case was one of organic congenital stricture of the esophagus at the cardia, but the subsequent ease with which the resistance gave way led him to believe that it was probably merely a case of cardiospasm. In the etiology of these cases of spasm of the cardia the congenital element is a likely factor. The spasm occurs at the point of normal constriction and is simply an exaggeration of normal spasm. This case, which represents a narrowing of the esophagus on the border line between a local organic condition and one of central spasmodic origin, is of a type exceeedingly favorable for treatment.

CASE 3.—The third case is that of a boy 5¾ years old. He was normally developed at birth. So long as he was fed on liquids and soft solids he did not vomit. There was no history of anything corrosive having been swallowed. When he was 5½ years old he began to vomit everything that he ate.

Physical examination revealed nothing abnormal. The bowels had been constipated but he had complained of no pain and there were no other symptoms excepting the loss of weight. The urine was normal.

Bismuth meals were given and Roentgen pictures taken at intervals. These revealed nothing abnormal in the chest, and the bismuth had passed into the stomach and intestines, showing that there was no pyloric stenosis. Figures 6 and 7 show this. He was then given bread and milk and again vomited after taking a few mouthfuls. A stomach tube No. 34 French, was passed and met with a resistance at a distance of 24 cm. from the incisor teeth. The normal distance from the incisor teeth to the cardia at this age, according to Morse, is about 27 cm. After a short time the resistance gave way and the tube was passed into the stomach as shown in Figure 8. The tube was then removed, a bismuth meal given, and a Roentgen picture again taken. Figure 9, the child lying on his face, shows the esophagus entirely full of bismuth and the presence of a stricture near the cardiac end of the stomach. He was then treated by having the stricture dilated every four hours. Later a bismuth meal was given without the tube and a Roentgen again taken. This (Fig. 10) shows that the bismuth has passed freely through into the stomach. Some days later he began to take liquids, having the tube passed only once a day for two weeks. After this he was able to take house diet without vomiting.

Dr. Greene at this time passed the esophagoscope and found that the esophagus was unusually roomy above the cardia, especially at its lower third. Spastic closure of the cardia was noted but this was relieved by slight pressure and the esophagoscope was passed through it. There were no signs of bagging of the esophagus nor any pouch, and the spastic closure of the cardia was always easily obliterated by slight pressure.

The child remained perfectly well for two weeks and then began to vomit everything, even water. A Roentgen picture then showed the presence of a foreign body in the esophagus, and Dr. Greene, by means of the esophagoscope, removed

a quarter dollar. Figure 11 shows the quarter prevented by the spasm from entering the stomach. The child then seemed perfectly well and there was no vomiting for a week. He then began to vomit again and when the esophagoscope was passed it revealed a piece of bristle just above the cardia. This was easily removed by forceps. Figure 12 shows the bristle. Since this time the child has occasionally had a slight spasm of the esophagus and dilatation has been done once or twice. The spasm, however, is growing less and probably will soon cease to appear. The child did not seem to be of a nervous temperament and his parents were not neurotic.

There seem to be two classes of esophageal narrowing irrespective of those of traumatic origin. Both classes will probably be found to be of congenital origin. One of them, however, is a localized organic condition in the walls of the esophagus, while the other is a functional, with possibly an additional organic, congenital condition of a brain center, which is represented by a lack of inhibition.

It is possible that pure spasms of the esophagus are mostly congenital and are located in the brain.

197 Commonwealth Avenue.

THE INFLUENCE OF ACTIVITY ON THE METABOLISM OF THE CHILD

TOGETHER WITH REMARKS ON THE ARTICLE,[1] "SOME FUNDAMENTAL PRINCIPLES IN STUDYING INFANT METABOLISM," BY FRANCIS G. BENEDICT AND FRITZ B. TALBOT

PROF. DR. MED. ARTUR SCHLOSSMANN
Director Children's Hospital
AND
DR. PHIL. HANS MURSCHHAUSER
Scientific Assistant in the Laboratory of the Hospital
DÜSSELDORF

While former authors have bestowed but little attention on the question of how the subjects of their investigations regarding metabolism behaved while under observation — whether they were still or moved — this circumstance of increased or decreased activity is of the most vital interest the moment we include respiratory metabolism in our investigation. The decomposition of N-containing matter is only to a slight degree influenced by activity, especially in the case of infants; but the decomposition of nitrogen-free matter, and with it the elimination of CO_2 rises immediately, as soon as the subject makes any action, moves or cries. Even in the second experiment which Rubner and Heubner[2] carried out on infants in the Pettenkoffer apparatus, these two authors attached very slight value to the performance of the child. They said:

> Physical rest and activity on the part of the subjects may be regarded as nearly, if not entirely, alike: considerable performance is, indeed, quite out of the question. In our estimation the normal child was somewhat more active than the weakly, emaciated child. Such differences, however, may be more or less completely compensated for by sleeping time and depth of sleep. In these slight differences of course is included also that which might at the time be termed individual characteristics. Hence with the matter under consideration one will be in a position to judge with all possible acuteness the effects of various forms of nourishment on the child.

We see that here *the significance of the child's accomplishments is still completely undervalued.* Here also a parallel is drawn between the normal child and the emaciated one in computing the transformation, a thoroughly inadmissible comparison, as we know to-day, for it is just the emaciated child that because of the abnormality of its superficies shows an abnormal giving-off of heat. In the first experiment of Rubner

1. Benedict, F. G., and Talbot, F. B.: JOUR. DIS. CHILD., September, 1912.
2. Rubner and Heubner: The Artificial Nourishment of a Normal and an Emaciated Child. Ztschr. f. Biol., 1899, xxxviii, 315.

and Heubner[3] these authors go so far as to state that the infant does not accomplish mechanical work to any extent worth mentioning.

But the importance of the child's activity is already recognized later by Rubner and Heubner themselves. In their third experiment they had an unusually sturdy and well-developed boy to deal with, who, by his activity, added extraordinary difficulty to their experiment. This child in the four days of observation put on 1.49 gm. N. According to this, an increase in weight of 70.5 might have been expected, instead of which the weight remained stationary and N-free substance was eliminated. Quite logically, Rubner and Heubner concluded from the figures obtained, above all from the fact that more C was eliminated than absorbed, that it is true albumin was formed, but that on the other hand, N-free substance, that is, fat or glycogen, was exhausted. The child must certainly have behaved itself in an excessively refractory manner while under observation. Heubner[4] says on this point:

> On the first day the child began to express in lively fashion his dissatisfaction with the new situation in which he found himself, not only by crying, but by literally raving, exerting all his sturdy muscles most strenuously in order to free himself from his imprisonment. On the next day, when he had accustomed himself to his new surroundings, he certainly cried less, but nevertheless as long as he was awake he was in a state of ceaseless muscular activity, now with his legs, now with his arms. Only during the hours of quiet and usually quite healthy sleep, which took place without interruption at night, were the child's muscles at rest.

Heubner thereupon points out that in this experiment the accomplishment of external muscular work has come to light, and that the consideration of this momentum in the balance of energy, and the possibility of its measurement by a comparison with the formerly observed infants are the most interesting conclusions of this last experiment. He closes his communication with the words that in the future, in judging the effect of nourishment, it will be permissible to take the consideration of the daily performance of crying and rest, and such like, more into account than has been, up to now, frequently the custom. In this publication, then, the significance of outward activity for the energy transformation of the infant is in general and in theory recognized, but the right conclusion as a basis for further investigations is not drawn. This conclusion must run as follows: *In physiological respiration experiments outward activity must either be totally excluded or we must measure the quantum of this activity and consider it in our calculation.*

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3. Rubner and Heubner: The Natural Nourishment of an Infant. Ztschr. f. Biol., 1898, xxxvi.

4. Heubner: A Further Contribution to the Knowledge of the Balance of Energy in the Infant. Verhandl. d. Gesellsch. Kinderh., 1904, xxi. Published by I. F. Bergmann, Wiesbaden.

In the observations undertaken by us, we have for years excluded, as far as possible, the outward activity of the subject. But as, indeed, the kind and quantity of the nourishment taken influences the excretion of CO_2 and the consumption of O, we set ourselves to carry out our experiments on sleeping and fasting children. From the outset it seemed difficult to let a child fast for over twenty-four hours, without its subsequently spoiling the experiment by restlessness. But it was found that these things are easier to carry out in practice than they would appear in theory. If, for example, a breast-fed baby is accustomed to take the mother's milk not directly from the breast, but from a bottle, the milk having been drawn from the mother, then it is easy to give this breast-fed baby, now accustomed to the bottle, a bottle filled with water that has been sweetened by saccharin instead of the bottle of milk. It must only be endeavored to suit the saccharin substitute to the child's taste. Let infants but consume the necessary quantity of fluid, and they bear hunger at times splendidly; i. e., they do not notice their hunger at all; they are not conscious of the fact that their life depends on their reserve

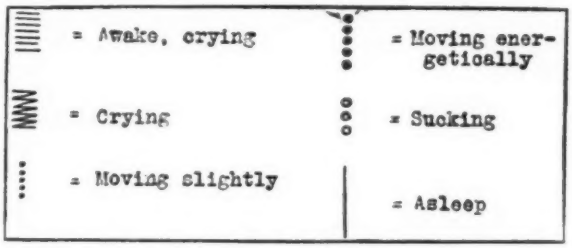

Fig. 1.—Explanation of signs. (See Fig. 3.)

forces. Of course, the natures of children, just like their temperaments, are different, and for such experiments one must be able to find out the suitably phlegmatic ones. Whoever is to a certain extent acquainted with the psychology of children will seldom miss the mark in the choice of his subjects.

Our procedure is, as a rule, that the child last receives nourishment at 7 o'clock in the evening, then in the morning, and all the next day it has water and saccharin and is petted a great deal. Older infants are played with and as far as possible kept happy, so that they soon go to sleep after having been put in the apparatus; or they are allowed to go to sleep beforehand and the experiment is begun with the sleeping child. Generally, we begin the experiment at 7 o'clock in the evening; the child has then fasted for twenty-four hours, and the effect of nourishment on the organism is eliminated. If one has good luck now and the child sleeps quietly in the apparatus for some hours, the experiment may be considered as an excellent one: *absolute physical rest in a fasting con-*

dition. The value of the excretion of CO_2 and the consumption of O, which we have ascertained in this manner, give us a glimpse of *the fundamental transformation of the infant. Fundamental transformation is the transformation of a person, reposing and fasting, that finds himself in comfortable, warm surroundings.*

Every movement made by the child increases the transformation of matter, and so increases the excretion of CO_2 and the consumption of O. For a physiological experiment, repose is the unconditional assumption, and we fully share the view recently expressed by Benedict: "Only periods of complete muscular repose are of any value." In their article in this Journal, also, Benedict and Talbot say very rightly:

> While it is not necessary to show that the metabolism of an active crying infant must of a necessity be considerably higher than that of a quiet child, it is not so well known that it is wholly illogical to compare metabolism of an active, restless, normal baby with that of a quiet, sick baby, since the amount of carbon dioxid excreted depends on the degree of muscular activity.

In order now to register whatever movements the children make while under observation, Benedict and Talbot[5] have described an apparatus which mechanically makes a graphic record of the child's movements. We have devoted the greatest attention to these movements in our researches, but have adopted another method of registering them. Thus Benedict and Talbot are not correct in writing:

> In all previous determinations of infant metabolism, either of direct energy transformations or by means of the direct calorimetry, either no recognition has been given to the significance of muscular movements on the part of the child, or it has been assumed that the child, when not crying or obviously restless, was quiet and with constant muscular activity. In other words, the notes accompanying these reports said, that the baby was either crying or quiet, i. e., asleep. The difficulties incident to securing long experimental periods of constant muscular activity with infants are only too well known, and yet an examination of the literature shows that almost invariably all of the longer experiments on infant metabolism have included periods of obviously great muscular restlessness and activity, as well as periods of crying.

We, on the contrary, have in all our researches in later years observed the child, and recorded the behavior of the child from quarter minute to quarter minute by quite definite signs. In Figure 1 is given the explanation of the signs employed by us. Figure 2 shows an ideal experiment, in which during three hours our child only twice made quite a slight movement in its sleep; and Figure 3, on the other hand, shows an experiment in which the child was decidedly restless. As has been said, all the experiments that we have published in the last few years show clearly how the child has behaved from minute to minute. Indeed, we adhere to the point of view that it is of absolutely no value to carry out and publish respiration researches in which this fundamental requirement is not complied with.

5. Benedict: Deutsch. Arch. f. klin. Med., 1912, cvii, 192.

It may appear questionable which is the better: the graphic method which we employ, which depends on individual observation of the child and on notes made two to four times per minute, or the mechanical record of Benedict and Talbot. Against our method it may with reason be objected that the judgment is exposed to the unavoidable vacillations of the observer. One and the same movement will be at one time recorded as being of a greater degree and at another time as being of a lesser degree, or *vice versa*. On the other hand, it is certainly to be remarked that the principal participators in our researches, since we have been working in Düsseldorf, are always the same persons, and not only the two authors of this article, but also the analyst of the laboratory and the

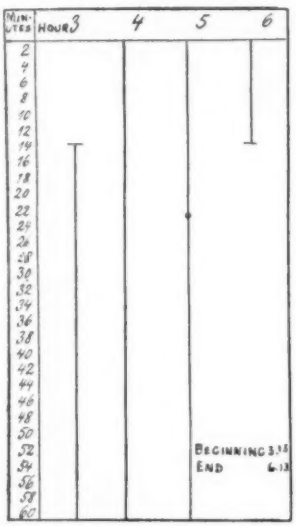

Fig. 2.—An ideal experiment, in which during three hours the infant (L) only twice made a slight movement in its sleep.

attendant. Hence a certain uniformity in the observance of the children's condition is assured and a possibility obtained of comparing the various experiments with each other.

But the method of Benedict and Talbot has also its disadvantages. The crying of the children, for instance, indicates a very considerable degree of activity, which is mainly performed by the respiratory muscles. But this activity will make slighter marks on the tambour than a movement of the leg or arm, in which less mechanical work is performed. Sucking movements of the child's lips will be not at all, or scarcely at all, visible, because a movement of the support under the child will not be affected by such an action, confined as it is to a single group of muscles. In short, a mechanical record, also, with all the aids to be had

therewith, will just as little render possible an absolutely exact view of the accomplishment, as the recording of personally observed movements. But under all circumstances — whichever method is used — exact observation of the activity in experiments with the respiration apparatus must be ensured, and included in the publication of these researches, if the observation is to have real value. On this point there is between Benedict and Talbot, on the one hand, and ourselves on the other hand, a perfect conformity of view.

Perhaps we may be allowed to take this opportunity of informing our American colleagues that it was possible for us to ascertain the worth of the fundamental transformation of the infant, which may be of value for further researches as standard figures. We found[6] that an infant of 4,325 gm., fasting and in complete repose, exhausted

9.03 gm. albumin
12.88 gm. fat and
28.32 gm. glycogen

of its physical reserves; that is, 273 calories. Fundamental transformation is accomplished in the cases of various infants, *ceteris paribus,* in proportion to the superficies; 1 sq. m. infant superficies has thus a fundamental transformation of 859 calories. By this means we can deduce the fundamental transformation of any normal infant with whose superficies we are acquainted, or whose superficies we can compute from its weight. The fundamental transformation of the infant fully synchronizes, moreover, with that of the adult, if here also the bodily superficies is reckoned as the basis of comparison; for Atwater found in adults a fundamental transformation of 840 calories per square meter, a figure which coincides ideally with that ascertained by us.

Now that we know the fundamental transformation, we can obtain a genuine conception of the accomplishment of the infant. One child whom we had under observation[7] cried during a part of the experiment, and at the same time made lively movements. In so doing, it exhausted per hour 2.764 liters more O than during the time of rest, that gave us a result *re* the fundamental transformation. From the increased consumption of oxygen, and from the increased formation of CO_2 it may be deduced that the child in this hour of unrest transformed 13.27 calories more. That is, then, 13.27 times 425 = 5,640 kg. of chemical

6. Schlossman and Murschhauser: The Fundamental Transformation and Nourishment Requirement of the Infant According to Researches on Gaseous Exchange. Biochem. Ztschr., 1910, xxvi.

7. As regards the behavior of this child while under observation, our report says: "It behaved itself in a very refractory manner, moved energetically, cried so that it grew red, and was not to be pacified." This description is strikingly similar to that which Heubner gives of the restless infant that he and Rubner had under observation.

energy, which were used in the activity of crying and during activity. Even if only the third or fourth part of these 5,640 kg. is to be accounted as really mechanical work, then this child of 5½ kg. accomplished work to the extent of from 1,400 to 1,900 kg. In another case we were able to ascertain that a fretful child of 2,680 gm. exhausted 0.785 liters more O per hour by crying. That, with a respiratory quotient of 0.90, corresponds to 3,899 calories, or 1,657 kg. of chemical energy transformed. Thus that would signify an actual attainment of about 500 kg., which this child of 2.68 kg. achieved by crying.[8]

If we, judging from our knowledge of the infant's fundamental transformation, consider the two breast-fed babies that served Rubner

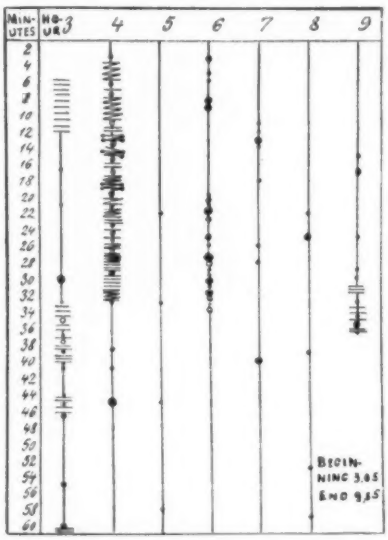

Fig. 3.—Experiment in which the child (P) was extremely restless. See Figure 1 for explanation of signs.

and Heubner in their experiments, in which the respiratory exchange, at least with regard to the excretion of carbonic acid, was ascertained, the following is shown: The first breast-baby, with a weight of 5,250 gm. and a superficies of 0.3500 square meters, absorbed 379.95 calories and decomposed 351.78 calories per day. The requirement for the fundamental transformation for this child amounted, according to our researches, to 300.65 calories. Thus there were used for activity expended 51.13 calories, and the fundamental transformation was exceeded by the accomplishment by 17 per cent. That corresponds to a chemical energy of 21.730 kg., or an attainment of over 5,000 kg. per day, if we assume an

8. Schlossmann and Murschhauser: On the Influence of Crying upon the Respiratory Metabolism of the Infant. Biochem. Ztschr., vol. xxxvii.

exhaustion of chemical energy of 25 per cent. for activity and 75 per cent. for formation of heat. The child elevated its weight about 1,000 meters in twenty-four hours, if we think of the manifold movements simply as a work of elevation. As the child at the same time slept a great deal, it accomplished during its waking hours extremely important mechanical work, contrary to the opinion of Rubner and Heubner that the infant does not perform mechanical work to an appreciable extent. The second breast-baby that Rubner and Heubner observed[9] was a perfect little acrobat. He weighed 9.77 kg., his superficies amounted to 0.5464 square meters, and he decomposed 660.5 calories. According to our researches, the fundamental transformation of this child amounts to 469.4 calories; consequently, the child transformed 191.1 calories more than were necessary for maintenance. But a total energy of 81,217.5 kg. is transformed from a potential state to a kinetic one, thus an effective work of around 20,000 kg. So the child elevated his own weight in twenty-four hours about 2,000 meters. The increase of the force transformation compared to the fundamental transformation amounted to 47.1 per cent. If one assumes that the child was absolutely quiet for twelve hours, it transformed in the twelve hours of activity about 100 per cent. more than when at rest; and so accomplished exactly as much as a child under our observation that cried for an hour and made energetic movements.

The description which so eminent an observer as Heubner gives of his subject, characterizes it as an excellent accomplishment. He says: "The child cries almost incessantly, has a reddened face, great beads of perspiration on face and arms," etc., all an indication of unusually strong, physical exertion, for which our figures give us abundant proof.

From all that has been said here it is proved of what great importance is the observation of children with regard to their movements and behavior during the carrying out of metabolism researches. Therefore, there was forced on us the importance of proving that we have ascertained by exact research the actual transformation during repose, and that for years in all our researches we have made exact records of the manner and intensity of movements on the part of our subjects.

9. Ztschr. f. Biol., 1898, xxxvi; Ztschr. f. exper. Pathol. u. Therap., vol. i.

IS DIPHTHERIA FREQUENTLY A BACTEREMIA?*

MATTHIAS NICOLL, JR., M.D. AND HARRIET L. WILCOX
NEW YORK

In August last, Conradi and Bierast[1] of the Hygienic Institute of the University of Halle reported the results of an extensive examination of the urine of diphtheria patients. They call attention to the fact, that, while diphtheria has been regarded as essentially a local disease, yet the Loeffler bacillus has frequently been isolated from the blood and organs after death, and occasionally from the blood during life, usually, however, in the agonal stage of the disease. On account of the technical and other difficulties of obtaining a sufficiently large quantity of blood from diphtheria patients, they sought to solve the question of diphtheria bacteremia by an indirect method, namely, an examination of the urine of those actively ill, and of convalescents. In all, 155 patients were examined, of whom fifty-four showed a positive urine. In six cases only, however, were virulence tests made, all of which proved positive. As the material was sent to the research laboratory at random, there was no possibility of following up a given case in order to study the question of the persistence of the bacilli by repeated examination. Of the 54 positive cases, 32 were female and 22 male; 36 children, 18 adults. Thirty-one urines were taken in the first week of illness, 10 in the second, 5 in the third, and 2 in the fourth. One was found positive in the ninth week of convalescence. The urine, 20 to 30 c.c. in amount, was taken by means of a sterile catheter with every precaution against contamination, and the centrifugalized sediment spread over one or two Loeffler plates and plates of Conradi and Troch. Both Loeffler and Neisser's stain were used for identification. The bacteria were found in normal as well as albuminous urine, showing that they pass through healthy as well as diseased kidneys. In most cases they were very few in number.

No clinical data are furnished in regard to the severity or outcome of the cases giving positive results. On the strength of their findings the authors make a plea for the disinfection of the urine of convalescents, until, by three negative cultures, it is shown to be free from diphtheria bacilli. They suggest that diphtheria of the skin and mucous membrane, which shows such a predilection for the genital and anal regions, is due to direct infection from the urine, and that the mystery that surrounds

*From the Research Laboratory, Department of Health, New York City.

*Read at the meeting of the American Pediatric Society, Washington, D. C., May, 1913.

1. Conradi, H. and Bierast: Deutsch. med. Wchnschr., Aug. 22, 1912, No. 34.

the origin of certain local epidemics of diphtheria may be explained in the same way.

Dr. R. Koch[2] of Frankfort, in December, reports the results of his examination of 111 urines from 26 patients. In 4 of these, which came from two patients, virulent diphtheria bacilli were found. In 10 urines from 5 other patients, diphtheria-like bacilli were found, which either could not be isolated in pure culture or else proved to be avirulent. In the original smears diphtheria bacilli were never recognized.

The urine was passed into a sterile vessel after thorough cleansing of the meatus with mercuric chlorid solution. In 74 examinations made on 19 patients suffering from mild or moderately severe diphtheria—in one case 14 examinations were made in 25 days—no suspicious organisms were found. In 5 other patients diphtheria-like organisms were found which proved to be avirulent; 2 of these were fatal cases. Post mortem examination of the urine proved negative.

Of the two positive cases, both ended fatally from the toxemia of the disease and cardiac paralysis. The first showed negative urine on the first two examinations, virulent diphtheria bacilli being found on the seventh day, the patient dying on the following day. In the second case they were found on the fifth day of the disease and the following day, being absent on the next five days and present on the twelfth day again, the patient dying the next day. The appearance of the bacilli in the urine was in neither case coincident with change in the general symptoms. The presence or absence of albumin in the urine had no bearing on the presence of bacilli.

Nineteen cases of scarlet fever complicated by diphtheria were examined as controls. In four of them the urine contained diphtheria-like bacilli which proved to be avirulent. We believe that only animal tests can be relied on for the identification of diphtheria-like bacilli in the urine. While Loeffler bacilli may occasionally occur in very severe cases, the fact is not of practical interest, as such patients, being confined strictly to bed, would not be likely to be a source of danger through infected urine.

The latest writer on the subject is Walter Beyer[3] of Rostock, whose reported results are little short of startling. He examined nineteen cases of diphtheria daily, or every second day, from the active stage of the disease to late convalescence. Forty c.c. or more urine were taken with proper precaution against contamination, and the centrifugalized sediment poured over a Loeffler plate. Practically every urine examined showed diphtheria bacilli at each examination; their number being greatest during the active stage of the disease and gradually diminishing.

2. Koch, R.: Deutsch. med. Wchnschr., Dec. 12, 1912, No. 50.
3. Beyer, Walter: München. med. Wchnschr., Feb. 4, 1913, No. 5.

In the case of eight convalescents, four of whom had recovered from their illness, three and one-quarter to three and one-half months previously, and the others eight, six, five and four weeks, respectively, the urine showed the continued presence of diphtheria bacilli, six strains of which were said to have been virulent for guinea-pigs, the other two avirulent. In all of the eight cases cultures from the tonsillar crypts showed diphtheria bacilli. It is to be noted that there is nothing said by Beyer or Conradi as to their methods of testing for virulence; that is, as to whether antitoxin was used in the test.

Beyer believes that it has been established beyond doubt that in the early stages of diphtheria, at least, the disease is essentially a bacteremia. Whether the organisms found in convalescents constitute also an evidence of a continued blood-infection he does not undertake to say.

Our series of cases comprises 54 patients with 56 examinations of urine. These were divided into three groups roughly corresponding to the type of disease which characterize the clinical material from which the three observers quoted obtained positive results. Thus the first group, 25 in number, consisted of routine cases; the second, 21 in number, cases of the severer type with a great deal of membrane and showing symptoms of toxemia; third, 8 in number, cases of recent convalescents. All were patients at the Willard Parker Hospital.

In the first group, there were 5 adults and 21 children, the ages of the latter ranging from 2 to 13 years. There were 18 males and 7 females. Twelve patients were in the first week of the disease, 7 in the second, 3 in the third, 1 in the sixth week and 2 not determined. Only 1 or 2 of these cases were of any severity. The urine proved negative in every case.

In the second group of 21 cases there were 4 adults and 17 children, the latter 2 to 11 years, 16 males and 5 females. Twenty were ill for a week or less at the time of taking the urine and 1 with croup and cervical adenitis for sixteen days. Two of this group proved positive. One, Edward M., 8 years of age, two days ill, had thick membrane covering the tonsils, fauces, uvula and posterior walls of the pharynx; there was also nasal discharge and marked toxemia. The serum tube and ascitic broth showed Loeffler bacilli which proved to be virulent. A specimen taken one week later was negative. The patient made an uneventful recovery. A second patient, Sam G., aged 5 years, had been ill three days. The patient had thick membrane on both tonsils, uvula and pharynx with profuse purulent nasal discharge. The cervical nodes were swollen and the patient very toxic. The serum tube and broth showed virulent Loeffler bacilli. The second specimen, taken eight days later, proved negative. Neither of these patients were catheterized on either occasion. Of the remainder of this group, from one, Hoffman's bacillus

was isolated, and from a case of diphtheria complicating scarlet fever and sepsis a specimen taken by catheter showed diphtheria-like bacilli, which, however, proved not to be diphtheria. All the other cases were negative.

TECHNIC

In the first two groups the female patients were catheterized, 20 or more c.c. of urine being drawn into a sterile centrifuge tube. In the case of males the first part of the urine was discarded and the residue passed into sterile centrifuge tubes through a sterile glass funnel. In one or two instances very young males were catheterized. In three cases only 8 to 12 c.c. of urine was obtained. The centrifugalized sediment was treated as follows:

One c.c. was drawn off by pipet, 0.8 of which was put into 3 to 4 c.c. of ascitic broth and the remaining 0.2 poured over a Loeffler serum tube and incubated. Colonies developing on the tube were examined in the routine way, and if any pellicle developed on the broth, it was stained with Loeffler's methylene blue and examined.

In the third group, although we had every confidence in our technic in producing equally if not more definite results than theirs, it was thought advisable to follow exactly that of the three writers quoted. The patients were catheterized after thorough cleansing of the meatus with mercuric chlorid solution and 35 to 40 c.c. of urine drawn into a sterile container. The centrifugalized sediment with 1 c.c. of the urine was drawn off by pipet and one-half of the quantity allowed to flow over each of two Loeffler plates previously tested with a known strain of Loeffler bacillus. In addition, in four cases 5 c.c. of the remaining urine was put into 75 c.c. of ascitic broth.

In this group there were eight patients, five of whom were females, five children and three adults. With one exception, they were all cases of clinical diphtheria of a pronounced type; the exception was a case which showed only a markedly congested pharynx from which cultures taken on several different days showed typical diphtheria bacilli. The patients had been ill from three to twelve days and were mostly afebrile at the time of the test. All showed the presence of diphtheria bacilli on culture in the throat.

In three cases there was no growth on the plates after twenty-four hours; in the other five, only colonies of cocci were present, probably staphylococci. The ascitic broth also proved negative.

CONCLUSIONS

The two positive findings in our series may well have been due to accidental contamination at the time of taking the urine, especially as a catheter was not made use of in either case. We conclude, therefore, that diphtheria bacilli may occasionally gain access to the blood and be

excreted in the urine in very severe cases of diphtheria with marked ulceration of the mucous membrane of the pharynx and tonsils. This fact is of theoretic interest, but of little practical importance to the physician. Finally, we believe that identification of diphtheria bacilli in the urine should not rest on morphologic characteristics alone, but be confirmed by isolation and animal inoculation controlled by the use of diphtheria antitoxin.

SIMPLE SYRINGE TRANSFUSION WITH SPECIAL CANNULAS

A NEW METHOD APPLICABLE TO INFANTS AND ADULTS

PRELIMINARY REPORT *

EDWARD LINDEMAN, M.D.
BELLEVUE HOSPITAL, NEW YORK

The entire apparatus for simple syringe transfusion consists of two sets of cannulas, two tourniquets and twelve syringes.

CANNULAS

Two sets of cannulas are employed, one for the donor, the other for the recipient (Figs. I and II).

There are three cannulas to each set (Fig. II; 1, 2, 3). Each cannula telescopes within the other as shown in Figure I.

The innermost cannula is practically a hollow needle, 2 6/16 inches long, 20-gage, with one end ground to a fine point and short bevel. The hollow needle (1, Fig. II) is fitted snugly into Cannula 2. Cannula 2 is 5 mm. shorter than the needle and is fitted snugly into Cannula 3. Cannula 3 is 5 mm. shorter than Cannula 2. The proximal ends of 1 and 2 are capped with stationary thumb-screw caps.

The proximal end of 3 is capped with a receiver to fit any Record syringe.

Cannula 3 is 2 inches long, 14-gage, .064 diameter. The caliber of this cannula is the same as the tip of a Record syringe.

In very small infants with very small veins only Cannulas 1 and 2 are employed, 2 being capped with the receiver to fit tip of syringe.

The syringes used are Record syringes of new improved type with a capacity of 20 c.c. and can be sterilized by boiling.

OPERATION

One operator manages syringe of recipient. Another operator manages syringe of donor. An assistant stands between operators, who are in a position close to the assistant. Donor and recipient are placed in the recumbent posture. Suitable veins are selected.

In adults and most children over 2 years of age the median basilic is easily accessible. In infants the external jugular or one of its tributaries is entered more advantageously. In some cases the internal saphenous may prove the vein of preference.

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* Read before the Pediatric Section of the New York Academy of Medicine, April 10, 1913.

* Manuscript submitted for publication April 19, 1913.

A tourniquet is placed in position, and the skin is sterilized with iodin. The cannula is then held in a position almost parallel to the vein with the thumb on the thumb-screw cap of the innermost cannula (1, Fig. I). The skin is then punctured and the cannula is forced into the vein. After the first joint A has entered vein, Cannula 1 is withdrawn a distance of about one-half inch. (This prevents the vessel wall from being injured or punctured by the needle after the vein is entered.)

With the thumb now on the thumb-screw cap of 2 the cannula is forced further in until the second joint B (Fig. I) has entered the vein. Cannula 2 is then withdrawn a distance of about one-half inch.. (Cannula 3 alone can come into contact with the vessel wall.) Cannula 3 is then gently pushed into the vein to a desirable length; usually three-quarters to one inch will suffice.

Fig. I

Cannulas 1 and 2 are now withdrawn entirely. If the vein has been successfully entered, blood will flow through the cannula. When the first drop appears a syringe containing warm saline solution is immediately attached and a very slow flow of saline is maintained through cannula. Escape of blood is thus prevented.

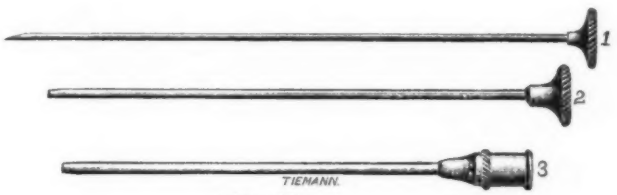

Fig. II

There is no need of haste at this stage.

A cannula is next inserted in vein of donor in a like manner; again a syringe containing warm saline is attached and loss of blood thus prevented. Everything is now in readiness for the transfusion. An empty syringe is substituted for the one containing saline solution, and blood is withdrawn from donor as rapidly as possible. When the syringe is full the assistant passes it to the operator on the recipient, who removes its saline syringe, attaches the syringe containing blood and evacuates the contents gently but speedily into the vein.

One syringeful of blood is followed by another in rapid succession until the desired quantity of blood has been transfused.

A little normal saline is injected through cannula of recipient after each syringeful of blood. This keeps cannula free of blood and precludes the possibility of clotting.

It has been found advisable for the assistant (or third man) to remove the syringe from the cannula of the donor as soon as filled. The operator can thus hold the cannula in place with one hand while with the other hand he may at once adjust an empty syringe into the cannula. Loss of blood is thus reduced to a minimum.

CASES

CASE 1.—(January 3, 1913) M. O., aged 9 years, weight 34 pounds. Cannula inserted in right external jugular vein on second puncture. Patient received 20 c.c. blood from a volunteer, blood being taken from median basilic.

CASE 2.—L. P., aged 4½ months, weight 6 pounds 5 ounces. Case of marked malnutrition. Cannula inserted in external jugular of patient on second puncture. Donor, mother. Cannula inserted into median basilic vein on first puncture. Patient received 75 c.c. of blood. Death two days later of malnutrition. No evidence of embolism clinically. Permission for autopsy was not granted.

CASE 3.—(March 19, 1913). J. T., aged 23 months, weight 19 pounds 12 ounces. Cannula inserted in median basilic vein of patient on third puncture. Donor, mother. A large needle instead of cannula was used in this case. This offered considerable difficulty and only 60 c.c. could be withdrawn from median basilic vein. Child received 60 c.c. of mother's blood. No evidence of embolism. Child doing well.

CASE 4.—(March 21, 1913) G. P., aged 6 months, weight 8 pounds. Cannula inserted in external jugular of patient on first puncture. Donor, mother. Cannula inserted in median basilic vein on first puncture. Patient received 90 c.c. mother's blood. No evidence of embolism.

CASE 5.—(March 22, 1913) P. R., aged 11 months, weight 12 pounds 4 ounces. Insertion of cannula in right and left jugular and both median basilic veins of patient failed. Right internal saphenous near ankle was then entered successfully. Donor, mother. Cannula inserted in median basilic vein on first puncture. Patient received 130 c.c. of mother's blood. No evidence of embolism. Child doing well. Hemoglobin before transfusion 50 per cent. Dare; four hours after transfusion, 75 per cent. Dare.

CASE 6.—(March 26, 1913) J. H., aged 4½ years, weight 28½ pounds. Cannula inserted in median basilic vein of patient on second puncture. Donor, father. Cannula inserted in median basilic vein on second puncture. Patient received 160 c.c. of father's blood. Hemoglobin before transfusion 62 per cent. Dare; Hemoglobin March 30, 70 per cent. Dare. Child is doing well and discharged from hospital March 30, 1913. No evidence of embolism.

CASE 7.—(March 26, 1913) N. L., aged 9 weeks, weight 6 pounds 6½ ounces. Cannula inserted into external jugular of patient on second puncture. Donor, volunteer. Cannula inserted in median basilic vein on first puncture. Patient received 50 c.c. of blood. No evidence of embolism. Length of time required in this case was nine minutes from beginning to end of operation.

CASE 8.—(March 29, 1913) M. O., aged 9 years, weight 35¼ pounds. This case is the same child mentioned in Case 1. Cannula was inserted in the same vein used January 3. Single puncture successful. Donor, volunteer, aged 24. Wassermann negative. Hemolytic tests negative. Cannula inserted in median basilic on first puncture. Patient received 280 c.c. of donor's blood. Hemoglobin before transfusion, 45 per cent., hemoglobin 4 hours after transfusion, 75 per cent., hemoglobin April 1, 70 per cent. No evidence of embolism. Child is doing well. Time required twelve minutes from beginning to end of operation.

CASE 9.—(March 31, 1913) G. N., aged 11 months. Cannula inserted in right jugular of patient on first puncture. Donor, mother. Cannula inserted in median basilic vein on second puncture. Child received 110 c.c. of blood. Hemoglobin before transfusion, 55 per cent. R.B.C. 2,800,000. Hemoglobin twenty-four hours after transfusion, 80 per cent. R.B.C. 4,400,000. No evidence of embolism. Time required not more than fourteen minutes. On admission the child had discharging ears and weeping eczema behind the ears. April 3d: Erysipelas about lobe of left ear and parotid region and over nose. Erysipelas present in two other children in ward at the same time.

RULES

1. Bright polished surfaces of syringe and cannulas are requisite.

2. A syringe used once should not again be employed until thoroughly cleansed with sterile water.

3. Air must be avoided. This, however, offers no difficulty.

4. Tourniquet of patient must be removed after vein is entered with cannula.

5. Tourniquet remains on donor throughout operation; momentary release of tourniquet may be advisable once or twice during course.

6. Dexterity and speed are requisite for success.

7. Syringes can be evacuated more rapidly than they can be filled without any harmful effects. This difference in time allows for attachment of syringe with warm saline following each syringeful of blood.

COMMENTS

The time elapsing in filling and evacuating the syringe is so brief that blood does not undergo any alteration from donor to recipient.

No lubricant has been employed except in one case. Cannulas are lined with a film coating of albolene.

Both arms of the donor may be used simultaneously.

Larger syringes with larger calibered cannulas may be used, but the present sizes have worked satisfactorily and fittings of syringe and cannulas are of universal gauge.

Syringes and cannulas may be kept sterile in individual metal containers. They are thus in readiness for immediate use and no preparation for operation is required.

The same vein can be used repeatedly for subsequent transfusions, since no thrombosis nor permanent injury to vessel occurs, as in Cases 1 and 9.

Any quantity of blood can be transfused and the quantity is definitely measured at the time of transfusion.

No skin incision was made in any of the cases presented in this paper.

Rubber tubings, various pumps and gravity have been employed on animals, but the best results have been obtained with the syringe cannula method.

In a later paper, Dr. LaFétra and I will present some new fields of application of blood transfusion. The present cases with others will be then discussed in greater detail. The object of this paper is simply to present a new and simple method of blood transfusion.

This work was done on the service of Dr. LaFétra in the Pediatric Section of the First Medical Service of Bellevue Hospital. I desire to thank him for the privilege of publishing these cases. I desire also to thank Drs. Stetson, Schroeder and Hill of the house staff, who assisted me in the work.

Since this article was sent for publication, I have done twenty-seven transfusions. These with the nine cases presented above make a total of thirty-six transfusions done by this method. Not a single mishap or untoward complication has occurred. The youngest patient was 7 weeks old, weighing 6 pounds 6 ounces. The largest quantity transfused was in an adult who received 1,200 c.c. The time required from beginning to end of the operation in these cases ranges from three to twenty-three minutes. The length of time the blood remains in a single syringe is from six to ten seconds. No skin incision was made and no anesthetic was given in any case.

A FORMULA FOR THE DETERMINATION OF THE SURFACE AREA OF INFANTS

JOHN HOWLAND, M.D., AND RICHARD T. DANA, PH.B.
BALTIMORE NEW YORK

Certain physiological functions are directly dependent on the surface area of the body. The heat elimination, as first shown by Rubner, and the excretion of carbon dioxid and the consumption of oxygen are *pari passu* proportional to the extent of the body surface. The study of the heat production of infants by Rubner and Heubner and Niemann, and of the infants' respiratory exchange by Schlossman, allows one to compare the different infants under the varying conditions of experimentation. They have been studied while fasting and while taking diets of different compositions. Some of the children have been well, some moderately and some poorly nourished. Great care has been used and much labor has been expended in making the different forms of apparatus and the experiments accurate in all details. The metabolism of the children has been compared on the basis of their surface area. It is evident, therefore, that the determination of the surface area should be very exact, for it obviously would be useless to determine the heat elimination painstakingly and with an error of only 1 or 2 per cent., and then use a formula for the surface area which may give an error of 15 per cent. or more. And yet, as will be seen later, this has been the case.

For the determination of the surface area various formulas have been proposed. Meeh[1] was the first to construct a formula for this purpose. He was anxious to obtain one applicable for all ages. His observations include the measurements of only three infants and these were all well nourished. The basis for Meeh's formula was the determination by Molischott that the volume of bodies of similar composition and form varies in the ratio of the cube root of their weight, and their surface areas in the ratio of the square root of their volume. He saw that the difference between the figures obtained from a formula, surface area $= \sqrt[3]{\text{Weight (in grams)}}^2$ and those from actual measurement would allow him to fix on a constant with which his results could be multiplied and thus surface areas calculated with reasonable accuracy. This constant was 12.3. But while the results for adults with the formula are satisfactory, they are not so for infants, as Meeh himself recognized would probably be the case; and he suggested that a smaller constant should be employed for infants. For this reason Rubner and Heubner used 11.9

1. Meeh: Ztschr. f. Biologie, 1879, xv, 425.

instead of 12.3, and with this the calculated surface areas of Meeh's three children were nearly the same as those actually measured. But when either of these constants is used to calculate the surface area of infants of different degrees of nutrition, the errors in certain instances may be extreme.

More recently Lissauer[2] has pointed out that either of these constants is too large for any but well-nourished children, and sometimes even for these. On the basis of twelve measurements of his own, almost all on poorly-nourished children, he has proposed 10.3 as a constant. While it is true that Meeh's formula with the constant 11.9, which has been used by Rubner and Heubner, Schlossmann and Niemann, is generally accurate for well-nourished children—but not always, as an error of 15 per cent. in one instance shows—it is very inaccurate for poorly-nourished children; and yet it has been used to calculate the surface area of all those infants with whom these authors have experimented, well-nourished and poorly-nourished alike. It is apparent that a formula is required that will have accuracy and elasticity so that it may be applicable to infants of all degrees of nutrition. Simplicity of calculation is also to be desired.

To this end we have constructed a formula of the $y = mx + b$ form, using the data supplied by Meeh and Lissauer. We have employed the weight as the only variable in the formula, as it is apparent from a study of the figures given by Meeh and Lissauer that the length and the circumference of the chest bear no necessary relationship to the extent of surface. It is not, therefore, imperative to introduce them into a formula as Miwa and Stoeltzner[3] have done, with resultant complexity and no assurance of greater accuracy.

The weight and surface area were first plotted on a chart similar to the one shown in the illustration, and a curve drawn which appeared to represent in the best way the conditions. This curve, by its distance from the axes OX and OY, represents an average of the observed data, so that when drawn to the proper scale, the point on the curve or line representing any known weight of child may be marked on the chart and the corresponding area read off directly. Thus, if we have an infant weighing 7,000 grams, and we desire to know his surface area, we find where the 7,000 gram line intersects the curve. Carrying this point horizontally to the left we find that it intersects the OY axis at a point corresponding to 4,100 square centimeters. The small circles on the chart are indicative of the fourteen observations given in the tables. The curve was drawn as nearly as possible to all these points, so that the average distance from any point would be as small as possible.

2. Lissauer: Jahrb. f. Kinderh., 1903, lviii, 392.
3. Miwa and Stoeltzner: Ztschr. f. Biologie, 1898, xxxvi, 314.

In the formula $y = mx + b$, which is the algebraic representation of this form of curve, x and y represent the abscissas and ordinates of the curve, b represents the distance along the Y axis from the origin to where the curve intersects the Y axis, and m represents the tangent of the angle that the curve makes with the x axis.

In this formula,
y = surface area of child in square centimeters
x = weight of child in grams
$m = 0.483$
$b = 730$

Having these last three quantities, it becomes possible to obtain the y or surface area by simple computation; b was read directly from the chart, and m was obtained by dividing 5,560—730 by 10,000.

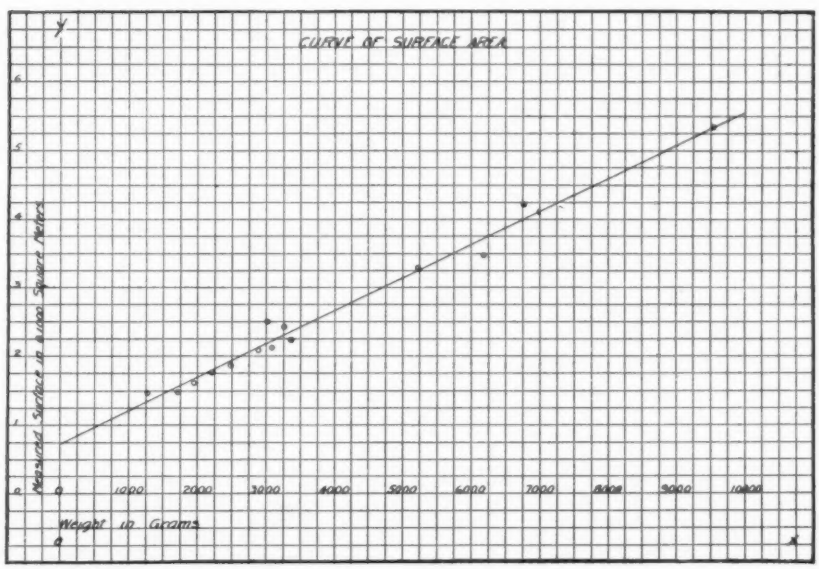

Chart showing weight and surface area determined as explained in the text.

This formula has the following advantages as compared with those of Lissauer and Meeh:

1. Accuracy.
2. Applicability to all conditions of nutrition.
3. Simplicity.
4. Elasticity.

1. The only accurate measurements of infants have been made by Meeh and Lissauer. They employed different but painstaking methods, and there is no reason to question the reliability of their results. They used, however, different types of children. Meeh was anxious to obtain

a formula accurate for all ages of normal individuals; Lissauer, on the other hand, measured with one exception only poorly-nourished and emaciated infants.

Meeh used millimeter paper laid on marked portions of the body and also accurately weighed paper for determining such areas as those of the nails. The extremities, fingers and toes were wound with circular strips. Lissauer measured cadavers by putting a colored adhesive material on the skin, pressing paper against the surfaces, and measuring exactly the stained portions after they had been removed. For infants between the ages of 6 and 435 days, there are available fifteen sets of observations obtained by these experimenters. One of these sets seems to be so decidedly abnormal that it should not be considered in the construction

No.	Surface sq. cm.	Weight / gm.	$12.3\sqrt[3]{W_L}^2$	Error %		$11.9\sqrt[3]{W_L}^2$	Error %		$10.3\sqrt[3]{W_L}^2$	Error %		$y=mx+b$	Error %	
				+	−		+	−		+	−		+	−
1	1462	1280	1450		0.8	1403		4.0	1215		16.9	1348		7.78
2	1482	1730	1773	19.2		1715	15.7		1485	0		1566	5.66	
3	1610	1960	1926	19.6		1864	15.8		1613	0		1677	4.16	
4	1768	2220	2081	17.7		2013	13.8		1742		1.5	1803	1.98	
5	1866	2500	2286	21.4		2192	17.4		1897	1.7		1940	3.97	
6	2092	2900	2501	19.6		2420	15.7		2095	0		2132	1.91	
7	2116	3100	2615	23.6		2530	19.6		2190	3.5		2229	5.34	
8	2230	3370	2764	24.0		2675	20.0		2315	3.8		2360	5.62	
9	2420	3270	2710	12.0		2622	8.3		2269		6.2	2311		4.51
10	2505	3020	2575	2.8		2490		0.6	2150	14.1		2190		12.55
11	3292	5230	3706	12.6		3586	8.9		3103		5.7	3260		0.97
12	3470	6180	4142	19.3		4007	15.5		3469	0		3715	7.07	
13	4222	6766	4310	2.1		4260	0.9		3885		12.7	4005		5.15
14	5345	9514	5530	3.5		5350	0		4630	13.4		5330		0.28
Total	35880		40349	12.4		39127	9.0		33858		5.7	35866		0

Table showing surface area of infants obtained by different formulas as compared with results obtained by actual measurement.

of a formula that is intended to express the results obtained in general form. The other fourteen are herewith tabulated in a comparative table showing the relative accuracy of the various formulas, namely, Meeh's, Rubner and Heubner's, Lissauer's and the one herein proposed. It will be observed that the gross error for the fourteen cases compares as follows:

	Per cent.
Meeh	12.4
Rubner and Heubner	9.
Lissauer	5.7
$Y = mx + b$	0.

whereas the individual calculations show less departure from and greater consistency with the observed facts by means of the new formula than with any of the others.

2. The tables also demonstrate that the formula $y = mx + b$ gives trustworthy results for all classes of children, the well- and the poorly-nourished, while the other formulas that have been proposed are not accurate in this respect. Thus Meeh's, and Rubner and Heubner's are fairly satisfactory for well-nourished children, but are very bad for the poorly-nourished; while almost the exact opposite may be said of Lissauer's.

3. By the other formulas it is necessary to take the cube root of the square of the weight of the child, multiplying this by an arbitrary constant, in order to obtain the desired area. In contrast with this, a simple multiplication and one addition are all that is required. A still simpler method of computing is by direct readings from a readily constructed chart, such as the one herewith presented, abscissas representing the weight in grams, and ordinates the desired areas in square centimeters.

4. This formula is constructed from the data at present available and can readily be applied to any future observations that may be made. No elaborate acquaintance with mathematics is necessary for this purpose. Future data may be plotted on this chart, and if it seems desirable to establish another curve to fit the then existing facts, the same can be done at sight and the new constant computed at a moment's notice. It should be mentioned in this connection that many more precise measurements on infants are needed in order satisfactorily to determine the average line. It is expected that with further observations, it will be necessary to alter this line somewhat, but the method of constructing the formula will still be the same and at the present time the formula is the most exact of those that have been proposed.

20 East Eager Street, Baltimore.

PROGRESS IN PEDIATRICS

THE DIAGNOSIS AND TREATMENT OF ENLARGED THYMUS

ALFRED FRIEDLANDER, M.D.
CINCINNATI

In the vast majority of cases of enlarged thymus we are dealing with a simple hyperplasia of the organ. For almost a century the literature has been filled with discussions of enlarged thymus, and just at present the problems of thymus physiology and pathology are being studied by numerous investigators from various viewpoints. The present paper limits itself to a consideration of the diagnosis and treatment of simple hyperplasia, necessarily leaving untouched any extended consideration of moot points in thymus physiology and pathology.

Among the rarer causes of enlarged thymus, primary tumors, especially lymphosarcoma, carcinoma and dermoid cysts must be mentioned. It is known that lymphoid infiltration of the thymus occurs in leukemia. Tuberculous infection has been reported and syphilitic lesions have been observed quite a few times. It is worthy of note that children with congenital syphilis not infrequently show a persistent thymus. Indeed, Vacher[1] is of the opinion that syphilis as such may be one important cause of the persistent thymus, even though the gland shows no specific lesions.

HISTORICAL

For nearly a century, to be exact, since the publications of Kopp in 1829, it has been known that a persistent or an enlarged thymus could cause disturbances of respiration. Indeed, our first description of thymic asthma came from Kopp. And it is noteworthy that his view that enlarged thymus could cause a true tracheostenosis with resulting compression disturbances, is to-day held by the majority of observers. The monograph of Friedleben appeared almost thirty years after Kopp's paper. Friedleben absolutely denied the possibility of mechanical compression of the trachea by an enlarged thymus, in fact, denied the existence of thymic asthma. And Friedleben's views were accepted until almost the close of the nineteenth century. Then Grawitz and Paltauf called attention anew to questions of thymus pathology. It was Paltauf who came to the conclusion that enlargement of the thymus constitutes

1. Vacher: Hypertrophy of the Thymus in Syphilitic Children. Thèse de Paris, 1911.

but one manifestation of an abnormal constitutional state. He found that in his cases of sudden death without apparent cause, there was not only an enlarged thymus, but in addition a hyperplasia of the entire lymphoid apparatus. The chief characteristics of the abnormal constitutional state, to which Paltauf gave the name of status lymphaticus, may be thus briefly summarized:

General enlargement of the lymph-node groups in various parts of the body, hypertrophy of the tonsils, of the follicles at the base of the tongue and of the intestinal follicles, enlargement of the spleen and its follicles and the presence of a thymus larger than usual, or a persistent thymus at a time of life when normally the thymus has atrophied.

STATUS LYMPHATICUS

In addition there is a hypoplasia of the circulatory apparatus, narrowing and thinning of the walls of the aorta and smaller vessels, with, at times, degeneration of the heart muscle. The individuals are of pale, pasty habitus, and in older patients the blood-picture of chlorosis is constant. Whether we accept Paltauf's lymphatico-chlorotic constitution, or status lymphaticus, as a clinical entity, or not, it must be admitted that in many cases there may be a simple hyperplasia of the thymus without the concomitant signs of status lymphaticus. This fact adds not inconsiderably to the difficulties of diagnosis. At the outset it must be noted that enlarged thymus need not produce any symptoms whatever. The large number of sudden deaths in apparently healthy children, with cause of death enlarged thymus, would suggest this immediately. It is known that hyperplasia of the thymus is very commonly found in association with Graves' disease in adults. Thus Matti (quoted by Crotti[2]) found 133 cases of hyperthyroidism in which post mortem had been held, and in ninety-eight cases (74 per cent.) hyperplastic thymus was found.

Intercurrent affections, notably the acute infectious diseases, often light up pressure effects of an enlarged thymus hitherto unsuspected. Thus in a case recently under observation a child who had been perfectly normal, apparently, was brought to the hospital after an attack of whooping-cough with the typical picture of thymic asthma. *Post mortem* a hyperplastic thymus was found.

DIAGNOSTIC SYMPTOMS

Nevertheless, in the majority of cases certain definite symptoms and clearly defined signs permit the diagnosis of enlarged thymus to be made *intra vitam*. The symptoms of enlarged thymus are three — dyspnea, either continuous or remittent, suffocative attacks and stridor.

2. Crotti: Thymic Tracheostenosis. Jour. Am. Med. Assn., Feb. 22, 1913.

The first diagnostic symptom to be noted, because it is the one most commonly present, is dyspnea. This dyspnea may be either permanent or intermittent. In his recently published monograph on the surgery of the thymus, Olivier[3] uses this symptom as a means of classification of cases.

The continuous form of dyspnea is the type most often seen in very young infants. The respiratory difficulty increases until the child has a suffocative attack, accompanied by intense cyanosis. The attacks are repeated with greater or less frequency, and death may occur during one of them. Between the attacks the dyspnea is continuous.

In the intermittent forms, children apparently quite normal, and usually several months of age, are suddenly seized with suffocative attacks accompanied by intense cyanosis, usually associated with convulsive movements of the extremities, followed after a few moments by a return to an apparently normal state. The intervals between the attacks, at first considerable, tend to become constantly shorter. Variations and gradations of the two forms are common, and have been frequently described.

The second symptom of frequent occurrence is stridor. This is usually inspiratory, though in extreme dyspnea an expiratory stridor is sometimes heard. In some cases the stridor is present from birth some time before even the dyspnea.

Now there can be no question of the very frequent association of congenital stridor and enlarged thymus. But it is surely not correct to assume, as do Haerttel[4] and Hochsinger,[5] for instance, that congenital stridor is always due to enlarged thymus.

Refslund and Koplik have shown that in certain cases of congenital stridor there is a peculiar malformation of the superior opening of the larynx. "The epiglottis has a gutter or beak-like form and is folded in the middle line." (Crotti.[2])

Again, Lees and Thomson have shown that occasionally congenital stridor is due solely to incoordination of the vocal cords, the result of muscular imbalance. The diagnosis of enlarged thymus is thus certainly not justified on the find of congenital stridor alone, though the presence of this symptom should in every case awaken suspicion, and lead to careful physical examination.

This should include as a matter of routine, the search for evidence of the nasopharyngeal lymphoid ring, and particularly of the follicles at the base of the tongue. There has been much discussion as to the possibility

3. Olivier: Anatomie topographique et chirurgie du thymus. Steinheil, Paris, 1911.

4. Haerttel: Zur Frage d. Thymustode. Dissertation, Greifswald, 1911.

5. Hochsinger: Stridor Thymicus Infantum. Vienna, 1904.

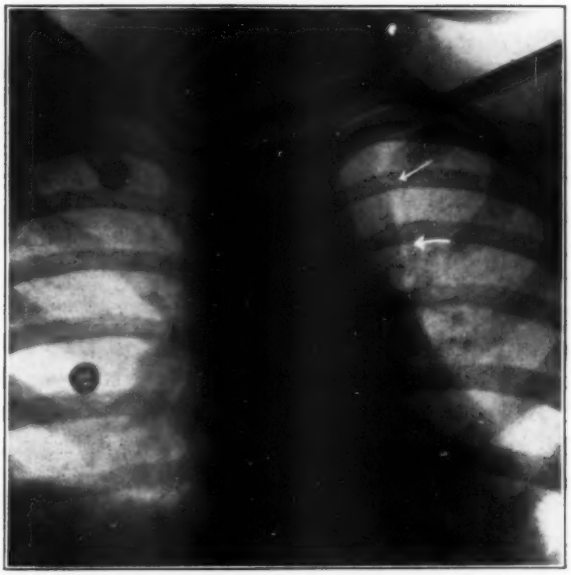

Fig. 1.—Enlarged Thymus. Broadening to left.

Fig. 2.—Enlarged Thymus. Broadening to right.

of actually diagnosticatng the presence of the enlarged thymus itself, but with the means at our command to-day, there can be no question of our power to do so.

PHYSICAL SIGNS

The physical signs of enlarged thymus are these: Detection of a mass in the jugulum by palpation, enlargement of the area of thymus dulness on percussion, the demonstration of tracheostenosis by bronchoscopic examination, or intubation, a special blood-picture, and finally the special type of thymus shadow as demonstrated by the *x*-ray.

In some cases palpation in the jugulum reveals the presence of a soft tumor, to be felt best during expiration. Attention was first called to this point by Rehn, but it must be admitted that it is an uncertain sign at best. This holds good also with reference to the bulging of the manubrium,[6] a sign surely absent in the majority of cases of enlarged thymus.

Percussion yields definite information of great value. Sahli[7] and Blumenreich[8] have formulated the principles for outlining the thymus by percussion. Blumenreich came to the following conclusions as the result of his studies: In young children there is a definite form of thymus dulness in the shape of an irregular triangle or truncated cone, whose base is the sternoclavicular junction and whose apex is the second rib. The sides extend but very slightly beyond the margins of the sternum, slightly more on the left than on the right side. Dulness extending more than 1 cm. on either side, concealing the note of pulmonary resonance between the heart dulness and the normal area of thymus dulness, shows, in the absence of other causes, an enlarged thymus.

Simply engorged lymph-nodes in the anterior mediastinum cause no dulness, while caseous nodes do. An important point to be noted is that dulness directly continuous from thymus to heart is always significant. Recently, Boggs[9] has claimed that the thymus dulness is movable, depending on whether the neck is flexed or extended, the difference amounting almost to an interspace. Personally, I have not been able to convince myself of this movable dulness, and quite recently Park and McGuire[10] have shown the incorrectness of Boggs' views, as the result of their anatomical studies. It may be remembered that Jacobi has claimed that the thymus is movable in the anteroposterior direction and that he has suggested percussing the thymus site with the child on its back and then

6. v. Mettenheimer: Jahrb. f. Kinderh., xlvi, 55.

7. Sahli: Topograph. Percussion im Kindesalter. Bern, 1882.

8. Blumenreich: Ueber die Thymus Daempfung. Virchows Arch. f. path. Anat., 1900, clx, 35.

9. Boggs: Percussion Signs of Enlarged Thymus. Arch. Int. Med., Nov. 15, 1911.

10. Park and McGuire: Arch. Int. Med., Sept. 15, 1912.

Fig. 3.—Enlarged Thymus. Broadening to right.

Fig. 4.—Enlarged Thymus. Cap.

percussing the area again from underneath with the child held face downward. So far as I know, there has been no confirmation of his findings of thymus motility in the anteroposterior direction.

DIAGNOSTIC METHODS

Basch and Rohn[11] have recently devised a special instrument for the percussion of the thymus. They claim that by its use in combination with auscultatory percussion and friction it is possible to obtain a more exact estimate of the size and conditon of the thymus than has hitherto been the rule.

Recently the bronchoscope has enabled skilled observers to demonstrate the existence of a tracheostenosis in certain cases of enlarged thymus. This diagnostic method (first employed by Jackson), is, however, of limited application only, owing to the difficulty of laryngoscopic and bronchoscopic examination in children. Intubation has occasionally led to the diagnosis of enlarged thymus, as in Rehn's first operative case, where the long tube had demonstrated the presence of obstruction low down in the trachea. In cases of enlarged thymus in association with status lymphaticus, the blood-picture may be of diagnostic value. Thus in a case reported by Rachford[12] in a child 1½ years old, the differential blood-count showed a total lymphocytosis of 72.8 per cent. with the general blood-picture of chloranemia. Naturally, in older children a marked lymphocytosis is of greater diagnostic import than in young infants.

The diagnosis of enlarged thymus has, however, been simplified very greatly of late by the means of the *x*-ray. At the outset it should be noted that for this diagnostic work, especially in young infants, high power machines, taking almost instantaneous pictures, are essential. With the slower machines the shadows are often so blurred, owing to movements of the child, as to greatly diminish their diagnostic significance. Great emphasis is laid on this point by Lange of Cincinnati, who has had a very considerable experience in thymus radiography. Since the appearance of Hochsinger's monograph,[5] the use of the *x*-ray as a diagnostic method in enlarged thymus has become universal.

The *x*-ray shadow of enlarged thymus is a wide median one. In some cases the broad shadow continues up directly from the heart shadow, in others the thymus shadow appears like a broad cap superimposed on the shadow of the heart and vessels. It must be admitted that a broadening of the shadow above the heart is not always due to enlarged

11. Basch and Rohn: Physical Evidence of the Thymus. AM. JOUR. DIS. CHILD., February, 1912, p. 82.

12. Rachford: *X*-Ray Treatment of Status Lymphaticus. Am. Jour. Med. Sc., October, 1910.

Fig. 5.—Enlarged bronchial glands. Right hilus.

Fig. 6.—Glandular hilus. T. B.

thymus. In a careful study of the interpretation of the thorax radiogram in the nursling, Benjamin and Goett[13] point out that a broadening of the shadow to the right may at times be due to the large vessels, especially the vena cava superior. But, as they note, this cannot hold good when the larger part of the shadow falls to the left of the vertebral column.

Ferrand and Chatelin[14] find that the thymus and heart give a distinct sharp median shadow. Enlarged bronchial glands give an extra median shadow, separate from the heart shadow and not connecting with it. This latter point is of importance. Myer[15] has also called attention to it. There does not appear to be any question as to the diagnostic value of the *x*-ray in many cases of enlarged thymus. But even as experienced a radiographer as Lange expressly insists that in certain cases, especially if the gland be increased in size laterally without augmentation of its anteroposterior diameter (the large flat thymus), the *x*-ray picture may not be conclusive. As has been well said: "Where the *x*-ray evidence is positive, it is of real value in diagnosis, but when it is negative it is not to be considered as final."

TREATMENT

Turning next to the question of treatment, it should be said at the outset that any discussion of the therapy of enlarged thymus must necessarily include some consideration of the method of production of symptoms. It hardly seems possible to deny that mechanical compression must play a very decided rôle. At the superior opening of the thorax of a young child, the so-called critical space of Grawitz, the anteroposterior diameter measures only 2 cm. As a rule, the hyperplastic thymus is more than 2 cm. thick itself, and must compress trachea, esophagus and the large vessels and nerves. But even granting that direct or indirect pressure cannot explain all the symptoms, and assuming the correctness of the view of toxemia from excessive internal thymic secretion (Svehla's hyperthymization), the fact remains that it is the enlarged thymus which gives rise to the threatening symptoms, or is the source of danger to the child. Drug treatment is absolutely of no avail; indeed, it has long been recognized that medicines had no power to relieve thymic asthma.

SURGICAL TREATMENT

Within recent years surgical intervention has therefore been sought, the first operation having been done by Rehn in 1896. This first operation (exothymopexy) consisted in elevating the thymus from behind the

13. Benjamin and Goett: Interpretation of the Thorax Radiogram in the Nursling. Deutsch. Arch. f. klin. Med., 1912, cvii, 107.

14. Ferrand and Chatelin: Value of *X*-Ray in the Diagnosis of Enlarged Thymus. Bull. Soc. Pediat. de Paris, 1911, p. 164.

15. Myer: Status Lymphaticus. Wien. med. Wchnschr., 1912, p. 1181.

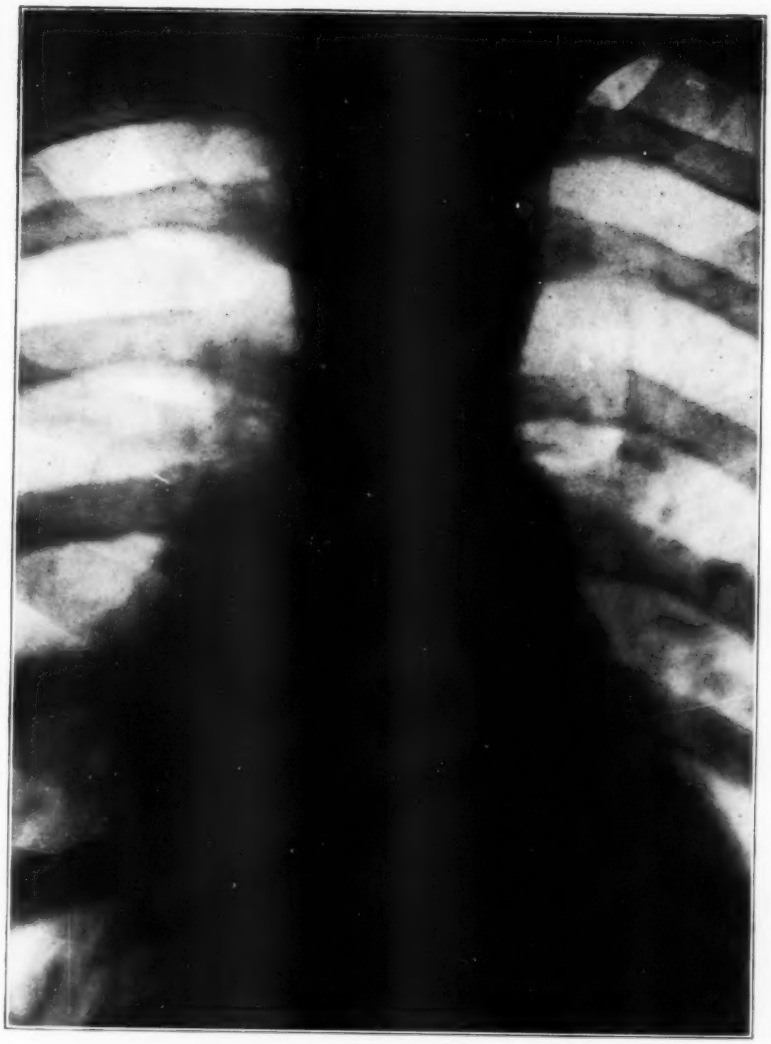

Fig. 7.—Glands at right heart.

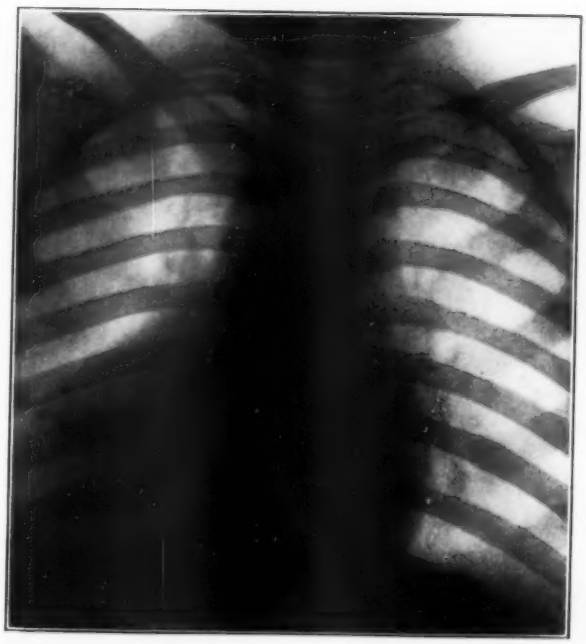

Fig. 8.—Congenital heart. (Pulmonary stenosis.)

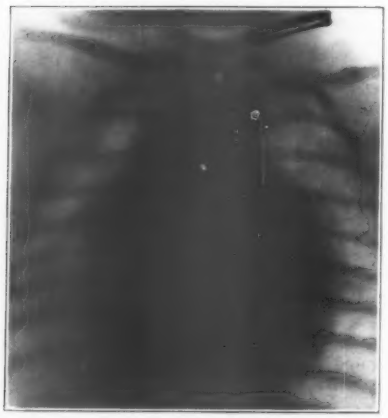

Fig. 9.—Congenital heart.

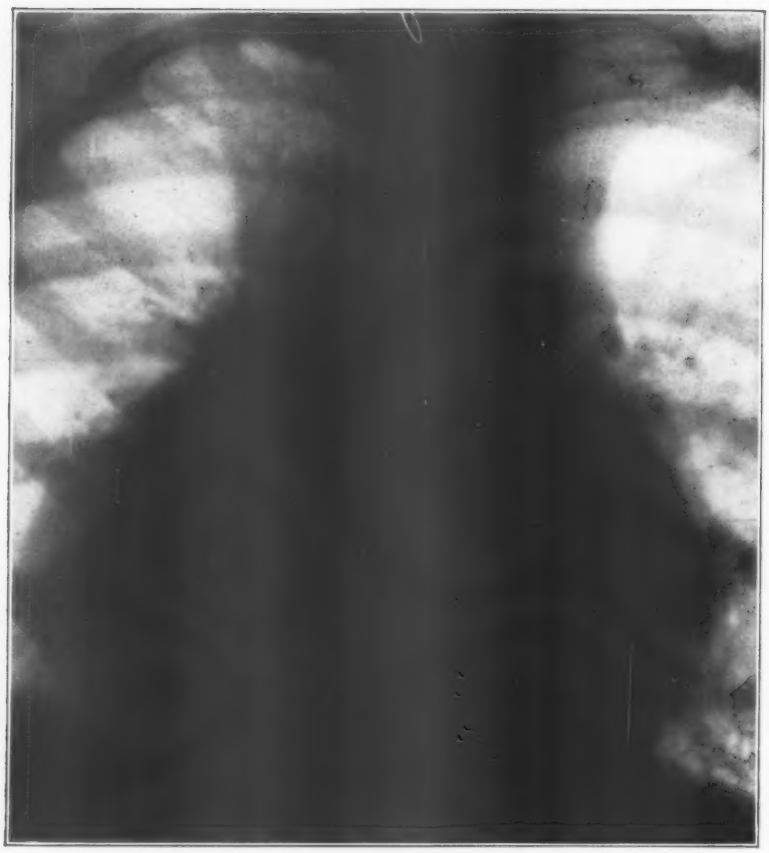

Fig. 10.—Pericarditis with effusion.

sternum and fastening it to the tissues of the neck or top of the sternum. The results of this operation were not good, and of late it has been superseded by the operation of removal of the gland (thymectomy).

The technic of this operation was worked out by French surgeons, especially Veau and Olivier.[3] The latter has published an exhaustive

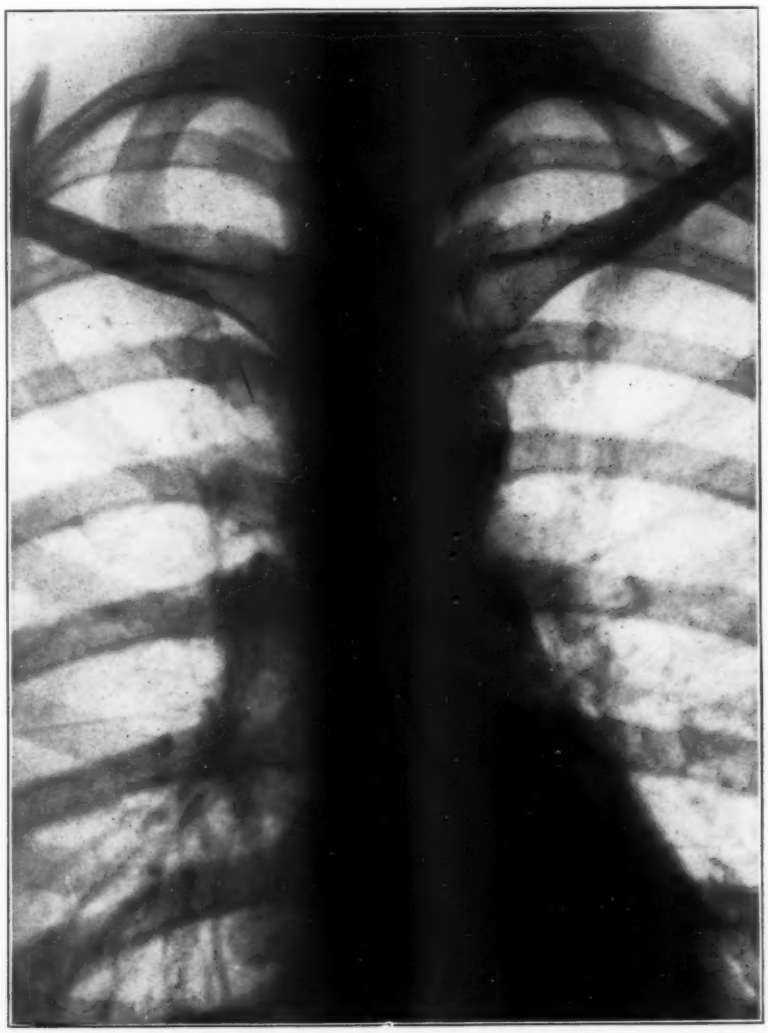

Fig. 11.—Fibroid mediastinitis. One lung stone.

monograph on the topographic anatomy and surgery of the thymus. A collection of all reported operative cases together with a most excellent résumé of the entire question has just been published by Parker.[16] Of

16. Parker: Surgery of the Thymus — Thymectomy. Am. Jour. Dis. Child., February, 1913.

the fifty patients operated on, seventeen died, showing a mortality of 33⅓ per cent. Even excluding some of the fatal cases, as Parker does for good reason, the fact remains that the mortality of the operation is high. Again, aside from the danger of the operation itself, it seems probable, in the light of recent research that the removal of all, or even of a greater part of the thymus may be fraught with grave danger to the subsequent development of the individual. The complete removal of the thymus during the period of its functional activity has been followed in the lower animals (rabbits, guinea-pigs, dogs) by very marked changes

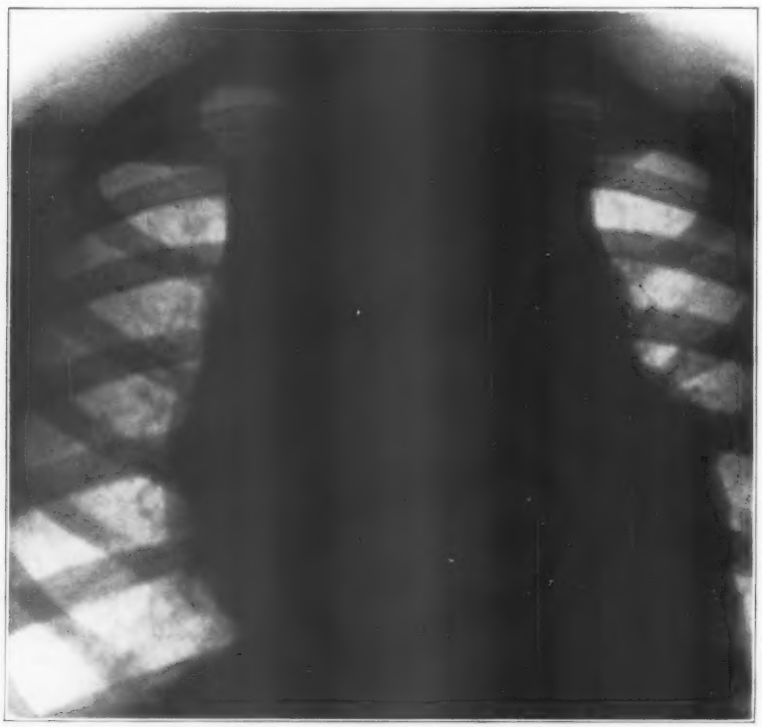

Fig. 12.—Lymphosarcoma. (Mediastinum.) Before treatment.

in the central nervous and osseous systems and in general development. While the animals have survived the operation itself, death has subsequently occurred in many instances under circumstances leaving no room for doubt as to the rôle of the thymectomy in its production. The experimental evidence of a good many observers is unanimous on this point, and the work of Basch,[17] Lucien and Parisot,[18] Klose[19] and Matti[20] gave

17. Basch: Jahrb. f. Kinderh., 1906, lxiv, 1908, lxvii.
18. Lucien and Parisot: Arch de med. exper., 1910, No. 10.
19. Klose: Arch. f. Kinderh., 1910, lv.
20. Matti: Mittheil. a. d. Grenzgeb. d. Med. u. Chir., xxiv, Nos. 4 and 5.
21. Heinecke: München. Med. Wchnschr., 1903, p. 2090.

identical results. Parker admits that the evidence is "strongly suggestive" that the thymus gland is absolutely necessary to life and normal development in the earlier stages of growth, but feels that its operative removal in the young human subject, so far as present evidence has shown, is not fraught with danger so far as subsequent development is

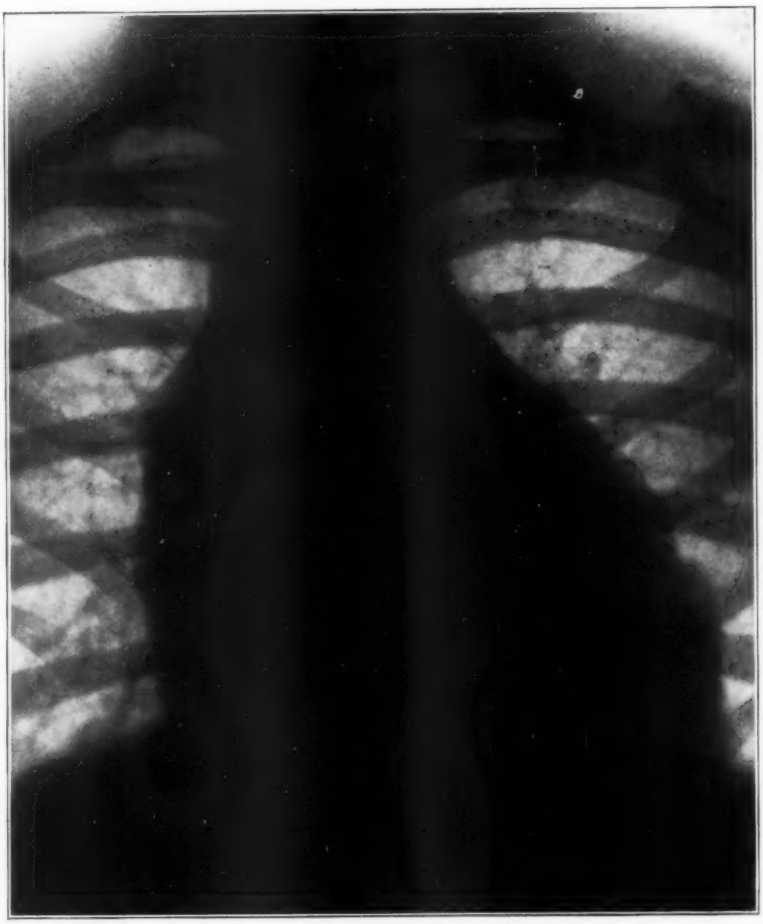

Fig. 13.—Lymphosarcoma. (Mediastinum.) After treatment.

concerned. And this because the gland is usually not completely removed. In the light of unanimous recorded experimental evidence concerning the effects of thymectomy on lower animals, this assumption certainly does not seem justified. We come now to the consideration of the *x*-ray treatment of enlarged thymus.

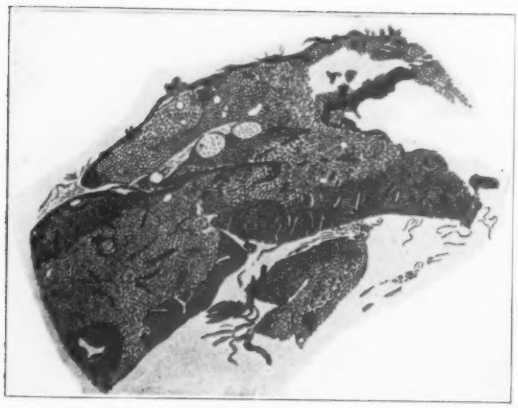

Fig. 14.

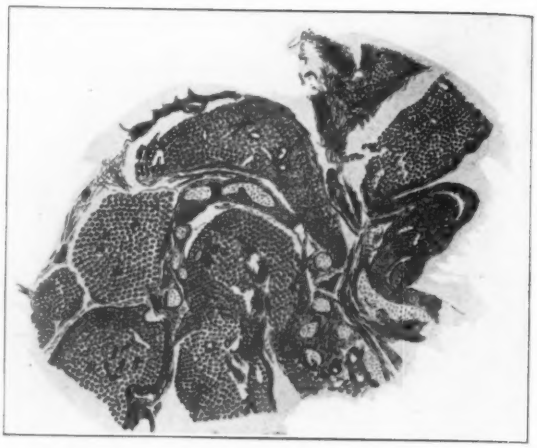

Fig. 15.

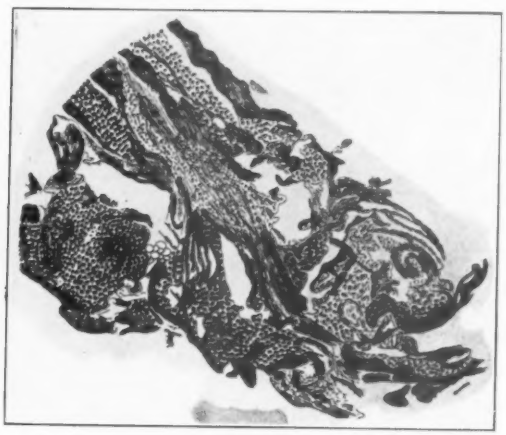

Fig. 16.

Fig. 17.

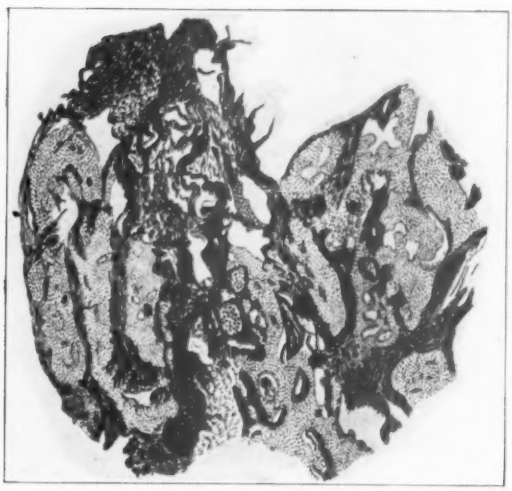

Fig. 18.

Fig. 19

Figs. 14, 15, 16, 17, 18, 19.—Artificial Thymus Involution. (Rabbit.)

ROENTGEN THERAPY

In 1903, Heinecke[21] published his studies on the effects of the *x*-ray on lymphoid tissues. He exposed young animals to the *x*-ray on successive days, then later killed the animals and studied the changes in the lymphoid structures. He found that the spleens of the animals showed

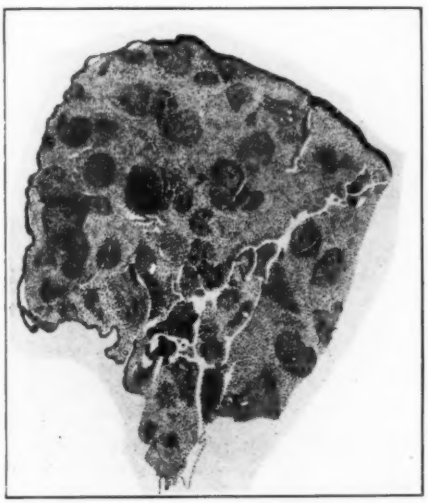

Fig. 20.—Rabbit Spleen. Normal.

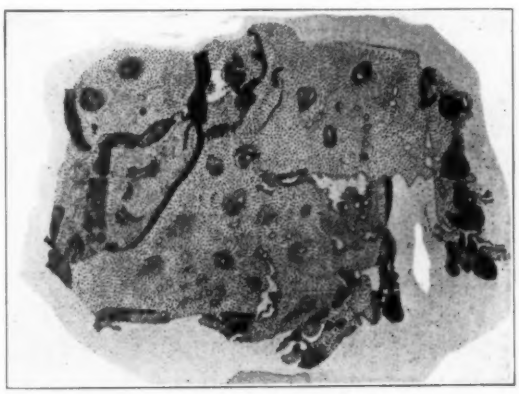

Fig. 21.—Rabbit Spleen. After treatment of the thymus region by the *x*-ray.

marked changes: increase of pigment, disintegration of cells, reduction in size of the malpighian follicles and rarefaction of the cellular elements. Analogous changes were found in all the lymph-node groups of the body, and, in very young animals, in the thymus. He suggested that it might

be possible that in the human being analogous changes might occur without skin reaction. In 1904, I had under observation a typical case of status lymphaticus with a greatly enlarged thymus in a 2-months old infant. The suffocative attacks were very severe, with dyspnea and cyanosis constant. In view of the desperate character of the case, the parents consented to allow the use of the *x*-ray, though, of course, no promise of relief could be held out. Twelve exposures in all were given, over a period of one month. The improvement was rapid, the suffocative attacks ceased, the thymus dulness became normal. The subsequent development of the child was absolutely normal, and at this writing the child is in perfect health. This was the first case of enlarged thymus successfully treated by the *x*-ray. Its publication was purposely delayed until 1907, in order that there could be no question of the result.[22]

Since this time, experimental studies by a number of investigators have demonstrated that it is possible to induce involution of the thymus by the *x*-ray. Aubertin and Bordet,[23] Rudberg,[24] and more recently D'Oelsnitz and Paschetta[25] and Regaud and Cremieu[26] have studied the process of such artificial involution in detail. In order to formulate the technic of *x*-ray treatment in cases of enlarged thymus, Lange and I conducted a series of experiments on rabbits, and showed that it was possible to induce any degree of fibrosis of the thymus, from the very slightest to absolutely complete fibrosis.[27] Reference to the latter point will be had later.

From the clinical standpoint the results have been extremely satisfactory as the published reports show. Since the report of my first case, there have been reports by various observers, of cases successfully treated — Myers,[28] d'Oelsnitz,[29] Rachford,[12] Weill and Pehu,[30] Ribadeau-Dumas and Weill.[31] In addition, Lange[32] of Cincinnati has record of eight other successful cases, not all of which have been reported as yet.

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22. Friedlander: Enlargement of the Thymus treated by the *X*-Ray. Arch. Pediat., July, 1907.

23. Aubertin and Bordet: Action de rayons *X* sur le thymus. Arch. des mal. du coeur et des vaisseaux. June, 1909, p. 321.

24. Rudberg: Studien ueber Thymusinvolution. Arch. f. Anat. u. Physiol. Supplement, 1907, p. 123.

25. D'Oelsnitz and Paschetta: Bull. Soc. pédiat. de Paris, 1911, p. 462.

26. Regaud and Cremieu: Thymus Involution by the *X*-Ray. Lyon méd., 1912, cxviii, No. 1.

27. Friedlander: Involution of the Thymus by the *X*-Ray. Arch. pédiat., October, 1911.

28. Myers: Arch. Pediat., August, 1908.

29. D'Oelsnitz: Compt. rend. de l'Assoc. francaise de pédiat., 1910, pp. 239 and 246; Bull. Soc. de pédiat. de Paris, December, 1911, p. 471.

30. Weill and Pehu: Lyon méd., December, 1911, p. 1448.

31. Ribadeau-Dumas and Weill: Soc. méd. d. hôp. de Paris, March 27, 1912; Weill: Bull. Soc. de pédiat. de Paris, October, 1912, p. 383.

32. Lange: Personal communication.

The attitude of one French surgeon, at this time, is also exceedingly significant. Veau[33] of Paris has to a large extent worked out the plan of operation of the intracapsular thymectomy. In Parker's collection of fifty thymectomies, he is credited with eleven of the cases, either alone or in consultation. At the meeting of the Paris Pediatric Society, held Nov. 12, 1912, Veau commented on Weill's paper reporting three additional cases of enlarged thymus successfully treated by the *x*-ray. He reported two successful cases of his own and added: "For over a year I have not done a thymectomy, and up to the present have never been disappointed in radiotherapy."

Including these two cases of Veau, there are thus twenty-five cases of enlarged thymus successfully treated by the *x*-ray. Some of these cases come in the category of the very severe, with life-threatening symptoms present. Yet the *x*-ray treatment has been uniformly successful; nor has a single untoward accident occurred. There have been no retardations in the development recorded. Contrasting the list of twenty-five cases successfully treated by the *x*-ray, with fifty thymectomies and a mortality of 33 per cent., it would seem justifiable to maintain that radiotherapy is decidedly preferable to surgical intervention. Any extended discussion of the actual technic of the application of the *x*-rays would be out of place in such a paper as this, but it may be permissible to note certain facts, elicited as the result of experimental study. Lange and I have found that intense fibrosis may be induced by a comparatively small number of exposures if they are given on successive days.

Thus in our work on rabbits we found that four exposures on successive days gave a greater degree of fibrosis than fifteen exposures over five and a half weeks. The shorter the interval between the treatments, the more marked the results obtained. When the symptoms of pressure from the enlarged thymus are very urgent, therefore, and when there is evidently very marked mechanical obstruction, the *x*-ray treatments should be pushed, being given on successive days, or even twice a day at first to get quick results. The results from the treatment are seen very promptly. After even the first treatment it is noted that the dyspnea is lessened and the suffocative attacks are less severe.

When the symptoms are not so urgent, treatment may be given at longer intervals. Clinically, it has been noted that the symptoms of thymic asthma, which gradually disappear under *x*-ray treatment, tend to recur after varying periods of time in some cases. This is doubtless to be explained on the basis of regeneration of the thymus after partial fibrosis has been induced. In such cases further courses of *x*-ray treatment are needed, and may be relied on to induce fibrosis again. Clinically, the dosage of *x*-ray can thus be regulated according to the neces-

33. Veau: Bull. de la Soc. Ped. de Paris, November, 1912, p. 426.

sities of the case. The danger of loss of thymus function (as in the case of complete thymectomy) is thus obviated and the metabolic changes after thymectomy are averted.

Although in all of the cases, both experimental and clinical, particular care has been taken to see that only the region of the thymus should be exposed to the action of the *x*-ray, we have found that after the *x*-ray treatment, changes in spleen and lymph-node groups could be noted. In two cases of status lymphaticus, one of my own, and one seen with Rachford and reported by him, we found that after the treatment the spleen and the lymph-nodes were notably reduced in size, coincidentally with the shrinkage of the thymus. Experimentally, Lange and I have been able to show not only marked reduction in size of the spleens of our treated animals, but also change in the histologic picture of the spleen. This observation opens an interesting field of inquiry with reference to the relation of *x*-ray treatment of the thymus and its effects on the general lymphatico-chlorotic constitution.

In our later clinical work, Lange and I have used much stronger *x*-ray dosage than was employed at first. No ill effects from the rays have ever been observed. The harmlessness as well as the effectiveness of the treatment have been abundantly demonstrated. With the larger dosage as now employed, with the rapid succession of treatments, prompt results may be looked for, even in the very severe type of cases. Fewer treatments are needed. The involution may be pushed as far as necessary without the slightest fear of later developmental abnormalities.

The promptness of response to the treatment is very noteworthy, marked improvement being usually observed even in the severest cases after the first treatment.

With the modern methods of precision the diagnosis of enlarged thymus has become much easier; with the *x*-ray treatment, successful therapy is assured.

4 West Seventh Street.

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ENGLISH CONFERENCE ON INFANT MORTALITY

An English-speaking Conference on the Prevention of Infant Mortality will be held in Caxton Hall, Westminster, London, on Monday morning, Monday afternoon and Tuesday morning, Aug. 4 and 5, 1913. The meetings will be held under the auspices of the (British) National Association for the Prevention of Infant Mortality and The Welfare of Infancy under the patronage of the King and Queen, and will convene immediately preceding the opening of the International Medical Congress.

A tentative program has been issued by the committee which indicates that the papers will consist largely of medical opinion. The subjects treated will be:

The responsibility of central and local authorities in infant and child hygiene.

The administrative control of the milk-supply.

The necessity for special education in infant hygiene.

Medical problems in infant nutrition.

Antenatal hygiene.

The president of the conference will be the Hon. John Burns, M. P., president for the Local Government Board. The chairman of the English Executive Committee is Sir Thomas Barlow and the secretary, Miss J. Halford, 4 Tavistock Square, London, W. C.

The American committee, in charge of the part to be taken by the United States and Canada, will furnish information to those desiring to attend the conference.

Dr. Henry L. Coit, chairman, 277 Mt. Prospect Avenue, Newark, N. J.

Dr. Philip Van Ingen, secretary, 125 East Seventy-First Street, New York City.